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Cancer of the Rectum[1]

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Pessimism regarding the possibility of cure and widespread abhorrence of a colostomy are responsible for many deaths from cancer of the rectum. The experience of the Neoplastic Service of the Metropolitan General Hospital (Windsor) over the past eight years leads to the conclusion that neither is such pessimism justified nor a properly managed colostomy objectionable.

Cancer of the rectum is particularly amenable to cure. Causing definite and usually early symptoms, the growth is so readily accessible for diagnosis that most cases should be discovered in an early stage. Metastases, usually late in developing, quite probably will not have occurred at the time the patient presents himself for treatment. Fortunately, also, should lymphatic involvement be present, not only the primary growth but those nodes most frequently first affected are readily removable. Patients with cancer of the rectum have a great likelihood of cure if they submit to a radical operation, for the five-year survival rate is higher than with most other forms of malignant growth.

The unfortunate experiences of a patient who has submitted to a colostomy as a merely palliative measure have prejudiced both laity and the profession against such a procedure. This patient, still suffering all the discomforts of an unremoved cancer, naturally places responsibility for his difficulties upon his colostomy. The entirely different experiences of the patient from whom the growth has been removed show the error in this judgment. Particular interest in this point, together with careful inquiry of our entire group of patients who have permanent abdominal colostomies following abdominoperineal resections, revealed that these persons are carrying on useful and practically unrestricted lives. They have very little, if any, difficulty with their colostomies; wear no appliances other than a small square of gauze to protect their clothing from mucus or accidental discharge, and without exception recommend the operation to anyone having a cancer of the rectum.

From 1928, the opening year of the Metropolitan Hospital, which is a typical well equipped 150-bed institution, until the establishment of the Cancer Clinic, in December 1935, 11 patients were admitted with a diagnosis of cancer of the rectum; in only one case, or 9 per cent, was the growth resected. This very small number of admissions indicates that most patients of that time were advised against operation as a useless procedure. During the eight years of the Clinic's operation,

[1] From the Neoplastic Service, Metropolitan General Hospital, Windsor, Ontario. Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1–2, 1943.

TABLE I: AGE DISTRIBUTION OF 83 CASES OF CANCER OF THE RECTUM

Age	No. of Cases
30–39	5
40–49	11
50–59	22
60–69	23
70–79	18
80–89	3
90 plus years	1

an equal period of time, 87 patients with cancer of the rectum have been admitted. In the early days of the Service many advanced cases were seen, but from 1936 to 1939, 40 per cent of the patients were radically operated upon, and in the last three years resection has been done in 60 per cent of all such cases. These figures, together with similar reports from other centers (3), show the modification of opinion now developing.

In the Clinic 83 patients, or 5 per cent of those treated for cancer, had cancer of the rectum. The incidence of rectal cancer was higher in men than in women in the proportion of 3 to 2. While the ages ranged from thirty-four to ninety years, the average was sixty, and more cases occurred in the sixties than in any other decade.

SYMPTOMS

Diarrhea was the most commonly noted first symptom and was reported in 26 of the 74 case histories giving complete information on this question. Bleeding 19, constipation 9, pain 6, discharge of mucus 3, weight loss 4, tenesmus 3, cramps 2, piles 1, and pruritus 1, were also given as the first symptom in the listed order of frequency.

The average patient put up with his first symptom for seven and a half months before consulting a doctor. Forty-nine per cent were referred for cancer treatment within one week of the original medical consultation, but 22 per cent were not under treatment for a period ranging from three months to two and a half years after first seeking medical aid. It is rather interesting that Table II, showing the loss in time after medical consultation, is almost identical with the corresponding table in our series of patients treated for cancer of the cervix (4).

TABLE II: LAPSE OF TIME BETWEEN FIRST MEDICAL CONSULTATION AND INSTITUTION OF TREATMENT FOR CANCER

Less than 1 week	49%
1– 4 weeks	23%
1– 3 months	8%
3– 6 months	9%
6– 9 months	5%
9–12 months	1%
12–29 months	5%

By the time of admission, which on the average was ten months after the onset of the first symptom, 85 per cent of the patients were noticeably bleeding, 50 per cent had diarrhea, and 59 per cent complained of tenesmus. Pain, discharge of mucus, sense of fullness, obstruction, and a prolapsing mass were features of some of the cases.

TABLE III: LAPSE OF TIME AFTER FIRST SYMPTOM BEFORE TREATMENT OF CANCER

Less than 1 month	13%
1– 3 months	26%
3– 6 months	16%
6–12 months	16%
1– 2 years	24%
2 plus years	5%

DIAGNOSIS

Digital examination is the most important single factor in the diagnosis of rectal cancer; in 90 per cent of this series the growth was palpable to the examining finger. Failure to make a digital examination was largely responsible for 40 per cent of the cases remaining undiagnosed for periods of one month or more. This procedure is diagnostic for lesions situated in the anus and ampulla and should never be omitted from a routine physical examination even in comparatively young patients. It may be necessary to perform the examination with the patient in several positions before the presence or absence of a tumor in the lower rectum can be determined. It is sometimes possible to feel a mass with the patient standing before the examiner in a half upright position, when the growth is not palpable in the recumbent position. If the knee-chest position is used for sig-

moidoscopy, it is necessary to make the digital examination before so placing the patient, or frequently the tumor will not be felt. On occasion, the examination is made in all three positions. Exploration of the entire circumference of the bowel is necessary. The findings vary somewhat with the type of lesion. Mucoid carcinomas have a soft consistency. If the growth is of the annular constricting type, the hard infiltrated wall and sometimes the crater of the ulceration can be felt. In more sclerotic forms one feels only an obliterating ring. In the papillary type a soft mass projects into the lumen of the bowel with little or no fixation in the early stages. The presence or absence of blood on the examining finger should be noted. Digital examination also gives some clue to the extent of the disease and its operability, and perirectal adenopathy and extrarectal induration can be determined. The importance of digital examination, however, lies not so much in the precision with which it is performed as in not omitting it.

In women, vaginal examination often assists in an estimation of the degree of infiltration, particularly in lesions of the anterior wall, and should never be omitted.

Sigmoidoscopy is an integral phase of the examination for rectal cancer, all but one or two of the tumors in this series having been readily demonstrable by this means. For tumors beyond the reach of the finger, it is of the utmost importance. No anesthetic is required. This examination is particularly important in the differential diagnosis of lesions situated in the lower part of the bowel. The findings are quite characteristic and, as a rule, permit one to establish definitely the nature of the disease. Furthermore, sigmoidoscopic or proctoscopic examination permits the performance of biopsy, which is at times an important aid in the diagnosis and in distinguishing between benign and malignant polyps. A biopsy is also of value in estimating the prognosis. A relatively small proportion (about 20–25 per cent) of rectal carcinomas belong at the extremes of cellular differentiation: the very malignant, totally anaplastic group and the highly differentiated variety. These two groups have quite different surgical prognoses. Since, however, about 75 to 80 per cent of rectal carcinomas are in the intermediate group of cellular differentiation, in which the histologic findings have less bearing upon the therapeutic procedure, grading is here of somewhat less importance than for many other tumors.

X-ray investigation in many cases had failed to demonstrate a low-lying cancer. The presence of a cancer of the rectum cannot be eliminated by a barium enema, and this examination should not be used routinely to diagnose or rule out the disease. At times, however, it will reveal a great deal of additional and useful information. In those instances in which it is impossible to pass the sigmoidoscope beyond the upper limit of the tumor, the x-ray aids in determining the extent of bowel involvement and the presence or absence of multiple lesions. It is a necessary procedure in demonstrating growths at a higher level in patients in whom the more frequently occurring rectal cancer has been proved absent.

TREATMENT

The treatment of cancer of the rectum, as with most other varieties of cancer, is either for palliation or for cure. During the past few years, a progressive broadening of the criteria for resection has resulted in a considerable decrease in the number of patients treated for palliation only. All too often, however, either by reason of the advanced stage of the growth or because of complicating factors, such as old age or severe myocardial disease, palliation is all that can be hoped for.

Treatment for Palliation: We believe that in the absence of complete or impending complete obstruction, surgery plays little or no part in the palliative treatment of carcinoma of the rectum. If numerous metastases or extensive involvement render completion of an at-

tempted resection inadvisable, it may at times be best to perform a colostomy. This is not true in most instances, although, as stated, there is no very great objection to a colostomy *per se* if the growth has been removed. The average patient in whom the growth is still present is a miserable object, whose difficulties are often only enhanced by a colostomy. Few such patients are at all satisfied with their colostomies; painful tenesmus and the other symptoms persist and the psychological reaction is bad. Eminent surgeons with much experience thoroughly condemn colostomy except for a really imperative obstruction, and it has been adequately shown that in the absence of obstruction, this operation does not result in any prolongation of life. While it is true that colostomy does temporarily relieve some of the symptoms of the otherwise untreated patient, this same relief usually can be obtained much more satisfactorily by external roentgen irradiation. It is time enough for a colostomy when obstruction becomes imminent.

The palliative treatment of choice is, we believe, 200 kv. roentgen irradiation administered at 50 cm. S.T.D. through anterior and posterior portals 10 × 15 cm., with a minimum filtration of 1 mm. of copper and 3 mm. of aluminum; 200 r, measured in air, is given daily for a total dosage of about 2,000 r to each of the two portals, care being taken that no reaction other than a very moderate reddening of the skin be allowed to develop.

Of 33 patients admitted for palliation, including several judged too ill for even this treatment, who soon died, the average duration of life after admission was eight and a half months, while the median duration from the onset of the first symptom directly referable to the tumor was seventeen months. Nathanson and Welch (5), reporting from the Huntington Memorial Hospital in Boston on a series of 77 untreated carcinomas of the rectum, give the median length of life from onset of the first symptom as fourteen months. We may therefore assume it unlikely that irradiation has prolonged life appreciably. Indeed, it is not given for this purpose, but primarily to afford some comfort and relief to the patient. We have irradiated 68 patients, and 70 per cent of these were definitely improved thereby. In practically all of these the bleeding and discharge ceased, at least temporarily, and they felt much better. In many instances the tumors became smaller and cleaner. Thirty per cent showed only slight or no improvement.

Of our patients treated solely by irradiation, 58 per cent have not required a colostomy. Colostomy was performed for threatened obstruction in 42 per cent, at intervals of ten days to twenty-one months following admission. If one excludes the colostomies deemed advisable at the time of exploratory operation, which might perhaps have been avoided, colostomy was performed in 30 per cent of the irradiated patients at an average of nine months after admission. These persons were considerably happier during this period than would have been the case had the colostomies been performed at an earlier date.

We do not believe that radium plays any appreciable role in the palliative treatment of rectal cancer.

Treatment for Cure: Treatment of rectal cancer for cure is essentially a surgical procedure, but we believe that preoperative x-ray therapy should be given in this as well as in many other varieties of cancer (1). Irradiation lessens bleeding, tenesmus, and pain and frequently brings about an accompanying improvement in the patient's health and general well being. The growth is diminished in size, infection is reduced, and the possibility of operative dissemination is lessened. This preliminary beam of radiation, uniformly distributed throughout the tumor, also provides an important foundation for a concentrated attack by radon or radium element implantation at the time of operation in those advanced cases in which the tumor has extended through the bowel wall and in all prob-

TABLE IV: TREATMENT EMPLOYED FOR CANCER OF THE RECTUM

Classification in Respect to Primary Treatment	No. of Cases	Subsequent Treatment				No Treatment
		X-ray Therapy		X-ray Therapy and Radium or Radon		
		No. of Cases	No. of Cases Requiring Subsequent Colostomy	No. of Cases	No. of Cases Requiring Subsequent Colostomy	No. of Cases
Refused operation	4	3	2			1
Metastases found at operation	9	7	5			
Abdominoperineal resections						
Alone 1						
With preoperative x-ray therapy 20						
With preoperative x-ray therapy and radium or radon implantation 10						
Following cecostomy 1						
Total abdominoperineal resections 32	32					
Admitted with a colostomy and declared inoperable elsewhere	5	3				2
Inoperable because of advanced nature of growth	11	8	3	2	1	1
Inoperable because of distant metastases	4	3	2			1
Inoperable because of concurrent disease or advanced age	12	9	2	1		2
Died following cecostomy for obstruction (total cecostomies 4)	1					
Alive with a cecostomy, awaiting decision as to resectability	1					
Local excision, referred for postoperative x-ray therapy	1	1				
For revision of colostomy after previous abdominoperineal resection elsewhere	1					
Very early, treated by radical irradiation alone	1			1		
Admitted with peritonitis from perforation and died following drainage	1					
TOTAL	83	34	14	4	1	7

ability is not removed completely by the operative excision. This possibility of incomplete removal has occurred with increasing frequency, as our operability rate has advanced from 40 to 60 per cent. During the period of preoperative irradiation one has also the opportunity of studying the patient, as well as the histology of his tumor, and frequently can form a better opinion as to the advisability of attempting resection.

In general, the technic of preoperative roentgen irradiation has been the same as for palliation. The total dosage has varied considerably throughout the series, as has the interval between completion of irradiation and operation. The optimum for neither of these factors has been determined. The earlier patients received doses ranging from 3,800 to 7,000 r and operation was deferred for a period of six to eight weeks, until the reaction had subsided well. More recently this method has been reserved for advanced cases, those that are less advanced receiving about 1,200 r to each of two fields, with operation one or two weeks later. The operation is not made more difficult by the preliminary irradiation nor have we found any interference with healing.

Preoperative preparation is of particular importance. An icteric index, which at times is of aid in the determination of liver metastases, and a non-protein nitrogen estimation are useful additions to the usual routine laboratory work. Since its availability, sulfaguanidine and more recently succinyl sulfathiazole have been given in large doses for four or five days prior to operation, apparently with very worth-while results. Anemia is combated by effective measures and a suit-

able donor is made available for the operation. Vitamin deficiencies are corrected and the liver is well supplied with glycogen. A low-residue diet is used and this is further restricted to high-caloric fluids and fruit juices for one or two days prior to operation. A few days' rest in bed in the hospital is also a very important preliminary.

Spinal anesthesia contributes toward a lowered operative mortality, and of the various preparations used for this purpose, dilute (1 in 1,500) nupercaine appears most satisfactory.

Any procedure which conserves the anal sphincter is to be condemned. No operation less extensive than an abdominoperineal resection with a permanent colostomy can be considered adequate. It is surprising how well elderly and seemingly very poor-risk patients can be prepared to withstand this rather formidable operation. The less extensive procedures are only a compromise and to date we have not felt impelled to use them. There have been two hospital deaths among the last 23 resections. They occurred in comparatively young patients, aged sixty and sixty-three years. Thirteen of the 23 patients were sixty years of age or older; 3 were seventy-four, seventy-six and seventy-eight years of age, respectively.

The operation may be performed in one or two stages. The two-stage procedure, as outlined by Lahey, is probably safer for the occasional operator, for the poor-risk patient, and in the presence of a partial obstruction. Obstruction necessitates some form of preliminary decompression and, in severe cases, is probably most safely done by a cecostomy, although one cannot readily empty the large bowel by this means. A cecostomy has been performed in several patients, followed by a single-stage abdominoperineal resection with subsequent closure of the cecostomy. Transfusion is carried out routinely during the resection and considerable shock is thus avoided. As stated above, radon or radium element needles are implanted in the base of the bladder or in other similar sites where adherence of the growth suggests the possibility of incomplete removal. In such cases, the preliminary x-radiation is of particular value in helping to build up a lethal tumor dosage. The perineal wound is sprinkled with sulfathiazole crystals and loosely packed over oiled silk, which is removed four or five days later. A single small liver metastasis should not prevent one from proceeding with the resection; the degree of subsequent comfort and prolongation of life render this procedure justifiable even though, under these circumstances, it becomes merely palliative in nature.

The operative mortality for the abdominoperineal resections in this series was 19 per cent, but increasing experience has lowered this to 9 per cent in the last 23 cases, despite the widening of the limits of operability. Sufficient time has not elapsed to determine the end-result of these procedures, but Lahey (2) and other surgeons have shown us that approximately 40 per cent of their patients have survived, free from evidence of growth, for five years after abdominoperineal resection. Of the 12 patients in this series in whom resection was successfully carried out three to six years ago, 3 died of cancer at fourteen months, nineteen months, and two years, respectively, after the date of admission; 2 are ill and probably dying of cancer; 7 are alive and seemingly well, 1 at six years, 1 at five and a half years, 1 at four years, 1 at three and a half years, and 3 at three years, providing a net survival, free from disease, of 58 per cent of those with successful resection. Inasmuch as all our recurrences to date have been within a three-year period, this figure probably approximates the five-year survival rate.

Treatment by Radical Irradiation: On occasion certain patients not considered suitable for surgery, for systemic reasons, but nevertheless theoretically curable, are treated by radical irradiation. Under such circumstances heavily filtered (2.5 mm. of copper) roentgen radiation at 80 cm. S.T.D. is given for a considerably larger

total dosage than is used preoperatively or for palliation. At times this treatment is supplemented by sigmoidoscopic interstitial implantation of radium element needles or radon.

Three patients were treated by such radical roentgen therapy. Two died at six and ten months; one, a woman 50 years of age with a completely inoperable, large, highly malignant, histologically verified adenocarcinoma which entirely filled the pelvis, responded so well to palliative x-ray therapy that the treatment was continued for a total dosage of 8,050 r measured in air. Four and a half years after treatment she remains in normal health, without any demonstrable sign of growth sigmoidoscopically or otherwise.

In a further 4 cases heavy external irradiation in this fashion was followed by implantation of radon. One patient, a young man who received 8,600 r and 1,680 mc. hr. of implanted radon in the form of gold seeds, died eleven months later of general carcinomatosis with multiple skin nodules and with the rectal growth apparently healed. A second patient, aged 66 years, with a grade 3 tumor which had been causing symptoms for two years, was treated with 9,050 r and 5,562 mc. hr. of radon. Twenty-one months later, after gaining 16 lb. in weight, he required a colostomy because of a rectal stricture, and this was followed by a further gain in weight of 6 lb. He died with an extensive pelvic recurrence exactly four years after first admission. A third patient, considered operable except for severe myocardial disease, died thirteen months after receiving 6,325 r and 2,035 mc. hr. of radon. The fourth, aged 50 years, had an early, freely movable growth, 2 cm. in diameter, apparently confined to the mucosal wall 5 cm. above the anal orifice. He was given 3,200 r, and after nine days 4.3 mc. of radon were implanted. He remains well four years and nine months later, with only a small scar visible at the site of the former growth. Re-examination histologically of the tumor has verified the original diagnosis of adenocarcinoma.

SUMMARY AND CONCLUSIONS

At first glance this report shows a low percentage of patients considered curable, but one must remember that our clinic is not a purely surgical clinic. We see many patients with advanced cancer or recurrences, many who have previously been operated upon, are elderly, or otherwise poor risks.

During the past three years we have recommended abdominoperineal resection to 74 per cent of the patients not previously treated elsewhere; 6 per cent refused operation. Of the growths operated upon, 80 per cent were resected; 16 per cent were found unresectable by reason of their advanced stage or the presence of metastases; 4 per cent of the patients died following cecostomy for acute obstruction before resection could be attempted.

The operative mortality would be lower and final results unquestionably would be more hopeful had the large group of borderline cases been given only palliative treatment. Such a procedure, however, is not in the best interests of the maximum number of patients, and any error made has been on the side of radical treatment rather than conservative.

Rectal cancer is by no means as hopeless as it was considered to be a few years ago. Patients who will act on what certainly should be considered alarming symptoms will be found operable in at least 70 per cent of cases, with an operative mortality of perhaps 10 per cent. They will have an even likelihood of a five-year cure without any very serious or real disability and be capable of a normal social and economic existence. For comparison, it is not generally recognized that only about 25 per cent of patients subjected to a radical mastectomy survive for as long as five years.

The operation is formidable and should not be undertaken lightly, or the mortality will be high. With adequate care and sufficient experience in the conduct of the case the operative mortality is not excessive.

Preoperative roentgen therapy is desirable and on occasion judicious use should be made of radon or radium element implantation at operation.

A small number of patients, systemically unfit for surgical interference, may be treated by radical roentgen or roentgen and interstitial radium therapy with not entirely unsatisfactory results, but this procedure is to be recommended only after grave consideration.

The progressively decreasing number of patients suitable for palliation only can be treated best by external roentgen irradiation. Colostomy frequently can be avoided under these circumstances and should not be performed except in the presence of imminent obstruction.

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Clinical Features, Diagnosis, and Treatment of Carcinoma of the Colon and Rectum[1]

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IT IS THE PURPOSE of this paper to present the clinical features and diagnosis of carcinoma at various sites in the colon and rectum and to enumerate the types of treatment given in 117 consecutive cases.

It has been stated that at least one person out of every 10,000 dies from carcinoma of the colon each year. When one considers, in addition, that the large intestine harbors 8 per cent of all carcinomas, the vast importance of an early diagnosis is obvious. It cannot be too strongly emphasized that a large percentage of cases can be cured, or at least be given considerable symptomatic relief for a long period of time, if adequate surgical procedures are early instituted. The general profession still tends to adhere to the old concept of the clinical manifestations of carcinoma of the colon and rectum, but it must be understood from the outset that there are no classical or pathognomonic symptoms of this condition, and particularly that the initial manifestations are so protean in character, and may be so closely simulated by other conditions, that it is easy to fail to make a diagnosis of an early carcinoma unless one establishes routine procedures in practice.

Of our entire group of 117 patients, the oldest was eighty-four years of age and the youngest thirty-two years; the average age was sixty years. There were 60 females and 57 males.

The number and percentage of carcinomas at each location were as follows:

Cecum	11	(9%)
Ascending colon	9	(7%)
Hepatic flexure	3	(2.4%)
Transverse colon	13	(11%)
Splenic flexure	10	(8.5%)
Descending colon	12	(10%)
Sigmoid	26	(22%)
Rectosigmoid	26	(22%)
Rectum	7	(5.9%)

From these figures, it appears that the pelvic colon harbors almost half of all the carcinomas of the large bowel, a fact which has also been reported by other observers. In the right colon, the cecum was the most common site, while the combined incidence of involvement of the ascending and hepatic flexures slightly exceeded that of the cecum. It was interesting to note in this group that the frequency at the splenic flexure was slightly over three times that at the hepatic flexure and that the incidence in the left colon was over three times that in the right colon. The free loop of the sigmoid showed the same incidence as the rectosigmoid, namely, 22 per cent, and the ampulla of the rectum 5.9 per cent. The value of a routine thorough rectal and proctosigmoidoscopic examination is apparent in view of the fact that 50 per cent of the carcinomas are in the sigmoid and rectum.

CARCINOMA OF THE CECUM

(11 cases or 9 per cent)

The cardinal symptoms of carcinoma of the cecum were abdominal cramps or colicky pain, in 72 per cent, and pain of a noncolicky character, in 18 per cent. One patient made no mention of pain. The pain was located in the right lower quadrant or in the right abdomen in 63 per cent; elsewhere in the abdomen in 27 per cent. Thus 90 per cent of the patients complained of abdominal pain, confined in the majority of cases to the right side.

Altered bowel function was also of cardinal significance and was present in 90 per cent of the series; in 10 per cent there

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was no appreciable bowel change. Clinical signs of obstruction were present in 72 per cent; 18 per cent had diarrhea, whereas 63 per cent complained of constipation, which varied from their usual habits.

The character of the stools was of some importance. Eighteen per cent had watery stools and 27 per cent tarry stools. Occult blood was reported in only 9 per cent, since most of the patients had had no examination for determining its presence.

A palpable mass was present in 63 per cent of the patients. The average loss of weight was 8 pounds. Secondary anemia and weakness occurred in 45 per cent of the cases.

An analysis of the duration of symptoms was of considerable interest; the shortest period was one week; the longest a year and a half; the average 6.7 months.

In brief, then, it will be noted that the cardinal evidence of carcinoma of the cecum is abdominal cramps or colicky pain, more commonly confined to the right side of the abdomen, associated with altered bowel function, in a person who has been ill for approximately seven months, with loss of weight, anemia, weakness, and a palpable tumor. All the patients in the group here reported complained, on admission, of three or more symptoms.

A correct roentgenologic diagnosis of carcinoma of the cecum was made in 72 per cent of the cases; a correct clinical diagnosis was likewise made in 72 per cent.

The treatment was as follows: resection in 6; short-circuit operations in 3; palliative ileostomy in 1; exploratory laparotomy in 1.

In one case which was diagnosed as carcinoma of the cecum, operation revealed adhesions about the cecum and terminal ileum from a previous inflammatory involvement, but no neoplasm was present. In a second case, which was diagnosed carcinoma of the cecum and ascending colon, with a mass, the surgical diagnosis was the same, while the pathological diagnosis was subacute colitis. There was no evidence of cancer or tuberculosis. In a third case a diagnosis of "no organic disease" was made, but because of the clinical findings the patient was operated on. The terminal ileum was bound down in several places to the lateral wall of the abdomen by dense adhesions. In the region of the ileocecal valve was a small hard mass. There were no nodes; no biopsy was done; an ileocolostomy was performed without resection.

CARCINOMA OF THE ASCENDING COLON
(9 cases or 7 per cent)

The cardinal symptoms of carcinoma of the ascending colon were abdominal cramps in 33 per cent and pain of a non-colicky nature in 66 per cent. The pain was confined chiefly to the right abdomen in one-third of the cases and was elsewhere in the abdomen in the rest.

Altered bowel function was characterized chiefly by obstruction and constipation in 77 per cent. Abnormal stools occurred in one-third of the cases, and 44 per cent had occult blood in the stools; in 33 per cent the stool was grossly tarry.

The shortest duration of symptoms was one month; the longest two years; the average eight months. Fifty-five per cent of the patients had a palpable mass, which was associated with an average weight loss of 18 pounds. Eighty-nine per cent of this group showed severe anemia, and weakness was manifested by three-fourths of the patients. All complained of at least three cardinal symptoms on admission.

The carcinomas were demonstrated and diagnosed roentgenologically in all cases in this group, or 100 per cent, whereas the clinical diagnosis was correct in only 55 per cent. It is interesting that this figure corresponds exactly to the percentage of patients having a palpable tumor, which apparently is usually the most significant finding in making a clinical diagnosis. In addition, in this group, abdominal pain, altered bowel function, duration of symptoms for an average of eight months, loss of weight, and anemia were significant findings, and they should always lead to suspicion of a malignant tumor of the bowel. The presence of the above symptoms in any

patient over thirty-two years of age make it imperative that the physician request a competent roentgenologic examination of the colon, for almost all cancers in this location can be diagnosed early by this method.

Two-thirds of the patients in this group submitted to surgery: 2 had resections with anastomosis; 2 had short-circuit operations; 2 had exploratory laparotomies only. Two patients were clinically inoperable and were discharged without surgery, and 1 patient came in for diagnosis only.

CARCINOMA OF THE HEPATIC FLEXURE
(3 cases or 2.4 per cent)

Abdominal cramps, altered bowel function, and abnormal stools were observed in the 3 cases of carcinoma of the hepatic flexure. The average duration of symptoms was 8.6 months, the shortest being three months and the longest one year. These patients had an average weight loss of 18 pounds, and 2 had anemia, weakness, and a palpable tumor. All complained of three or more cardinal symptoms on admission.

Both roentgenologic and clinical diagnoses were made in these 3 cases. Only 2 patients were operated on; each had a Mikulicz resection. The other patient came in for diagnosis only.

CARCINOMA OF THE TRANSVERSE COLON
(13 cases or 11 per cent)

The cardinal symptoms of carcinoma of the transverse colon were abdominal cramps, which were present in 30 per cent, and pain of a non-colicky nature, in 50 per cent. In the remaining cases, pain as a symptom was not especially noted in the records. Four patients complained of pain in the upper abdomen, whereas 4 complained of lower abdominal pain. In the rest the specific location was not mentioned in the clinical records.

Altered bowel function consisted in obstruction in 76 per cent of the series: constipation was complained of by 53 per cent, and alternating constipation and diarrhea by 23 per cent. The average duration of symptoms was seven and a half months, the shortest being one month and the longest two years. The average loss of weight was 17 pounds, and one-third of the patients had a palpable tumor. It was interesting to note that only 15 per cent had anemia, whereas 76 per cent complained of weakness. All patients had three or four cardinal symptoms on admission.

The roentgenologic diagnosis was correct in 92 per cent of the cases, and the clinical diagnosis in 76 per cent. In one case x-ray diagnosis revealed an atypical irregular filling defect of the sigmoid, and a diagnosis of carcinoma was made. Operation revealed numerous masses involving the transverse colon, peritoneum, liver, and sigmoid, and led to a surgical diagnosis of carcinoma of the transverse colon. The histologic diagnosis, however, was papillary adenocarcinoma of the ovary with extension and distribution to the areas described.

Four patients in this group had resections with anastomoses; 1 had a short-circuit operation; 1 had a palliative colostomy; 2 had exploratory laparotomies only; and 5 patients were considered to be inoperable.

CARCINOMA OF THE SPLENIC FLEXURE
(10 cases or 8.5 per cent)

The cardinal symptoms of carcinoma of the splenic flexure were abdominal cramps, in 70 per cent, and pain of a non-colicky character, in 30 per cent; 80 per cent of the patients complained of pain confined largely to the upper abdomen, whereas 20 per cent had pain in the lower abdomen. Altered bowel function consisted in obstruction in 70 per cent, with constipation in the same percentage; diarrhea was present in 10 per cent. The character of the stools was changed or abnormal in 50 per cent, and the average duration of symptoms was 7.9 months. Twenty per cent of the patients had a palpable tumor associated with anemia, whereas 50 per cent complained of weakness. All patients

complained of three or more symptoms on admission.

The roentgenologic diagnosis was correct in all cases; the clinical diagnosis was correct in 60 per cent.

Eight patients were operated on and 2 came in for diagnosis only. In 4 a Mikulicz operation was done; in 1 a palliative colostomy; in 2 a resection with permanent colostomy; and in 1 an exploratory laparotomy only.

CARCINOMA OF THE DESCENDING COLON
(12 cases or 10 per cent)

In carcinoma of the descending colon the cardinal symptoms were abdominal cramps and colic, in 75 per cent, and pain of a non-colicky character, in 25 per cent. Slightly over 50 per cent of the patients had pain in the lower abdomen, confined largely to the left side, and the rest had generalized abdominal pain. Evidence of bowel obstruction was present in 83 per cent and diarrhea in 16 per cent; 75 per cent of the patients complained of constipation. The character of the stools was changed in one way or another in 65 per cent.

The average duration of symptoms was 6.4 months, the shortest being one day and the longest eighteen months. The average loss of weight was 10.3 pounds, and 60 per cent of the patients had a palpable tumor. Anemia was present in 50 per cent, and 58 per cent complained of weakness. All of the patients had three or more cardinal symptoms on admission.

All cases were correctly diagnosed roentgenologically, whereas the clinical diagnosis was made in two-thirds of the cases.

Treatment was as follows: Mikulicz operations in 3; palliative colostomy in 2; resection with permanent colostomy in 3; short-circuit operation in 1; exploratory laparotomy in 1. Two patients were seen for diagnosis only.

CARCINOMA OF THE SIGMOID
(26 cases or 22 per cent)

The cardinal symptoms of sigmoid carcinoma were abdominal cramps or colic, in 42 per cent, and pain of a non-colicky character, in 30 per cent; in 28 per cent of the cases the clinical histories made no specific mention of pain, but undoubtedly most of this group had varying degrees of distress. The pain was located in the lower left quadrant in 33 per cent, while approximately 28 per cent had generalized abdominal pain; the rest of the records were non-specific as to location of the pain.

Altered bowel function was characterized by obstruction in 88 per cent of the series; diarrhea occurred in 15 per cent and constipation in 65 per cent. Alternating constipation and diarrhea were present in 11 per cent, and among those cases in which the character of the stools was described, slightly over 50 per cent were abnormal.

The average duration of symptoms was 6.1 months, the shortest being four days and the longest twenty-four months. The average loss of weight was 11.6 pounds, and 26 per cent of the patients had a palpable tumor. Anemia was present in 23 per cent and weakness in 46 per cent. All but one of the patients (*i.e.*, 96 per cent) complained of three symptoms or more on admission.

The roentgenologic diagnosis was correct in 87 per cent of the series, and the clinical diagnosis in 60 per cent. In one case the roentgenologic diagnosis was annular carcinoma of the sigmoid at its proximal portion; the surgical diagnosis was the same, with mesenteric nodes, but the pathological diagnosis was regional colitis. In a second case the roentgenologic diagnosis was "suspicious of carcinoma of the sigmoid;" operation revealed carcinoma of the ovary involving the sigmoid, peritoneum, mesentery, liver, and cul de sac. A third case, diagnosed roentgenologically and surgically as annular carcinoma of the sigmoid with obstruction, was shown pathologically to be regional colitis.

Twenty-two patients were operated on; 10 had Mikulicz operations; 8 had palliative colostomies; 1 had resection with anastomosis; 3 had exploratory laparotomies only. Of the 4 patients who were

not operated on, 3 were in a critical condition and 2 of them died several days after admission; 1 patient came in for diagnosis only.

CARCINOMA OF THE RECTOSIGMOID
(26 cases or 22 per cent)

The cardinal symptoms of carcinoma of the rectosigmoid were abdominal cramps and colic, which were noted in 34 per cent of the cases, and pain of a non-colicky character, present in 34 per cent. In 32 per cent the clinical history made no specific note of pain, Sixty per cent of the patients complained of pain in the lower abdomen, predominating on the left side; 8 per cent of upper abdominal or generalized pain. In 32 per cent no definite mention was made of pain.

There was evidence of bowel obstruction in 68 per cent; diarrhea occurred in 30 per cent, and constipation in 50 per cent. Alternating constipation and diarrhea were present in 15 per cent. Fifty-four per cent of the patients had abnormal stools, 49 showing gross blood.

The average duration of symptoms was ten months, the shortest two weeks and the longest thirty-six months. The average loss of weight was 15.9 pounds, and 34 per cent of the patients had a palpable tumor. Fifty per cent complained of weakness and showed anemia. All of this group complained of three or four symptoms on admission.

A correct roentgenologic diagnosis was made in 92 per cent of the cases and a correct clinical diagnosis in 84 per cent. In one case the roentgenologic diagnosis was an obstruction at the rectosigmoid with marked irritability, but the patient could not retain the enema long enough to determine the character of the lesion. However, the findings were suspicious of carcinoma. The surgical diagnosis was carcinoma of the rectosigmoid and the pathological diagnosis was adenocarcinoma. In a second case the roentgenologic findings were described as "not characteristic; one must consider atypical manifestations of either carcinoma, ulcerative colitis or diverticulitis." Proctosigmoidoscopic examination showed findings consistent with carcinoma. The surgical diagnosis was carcinoma, and an abdominoperineal resection was done. The pathological diagnosis was adenocarcinoma, grade III.

The treatment in this group was as follows: combined abdominoperineal resection in 3 cases; Mikulicz operations in 2; permanent colostomies in 11; exploratory laparotomies in 2. Two patients were clinically inoperable and 6 came in for diagnosis only.

CARCINOMA OF THE RECTUM
(7 cases or 5.9 per cent)

The cardinal symptoms of rectal carcinoma were abdominal cramps or colicky pain, present in 70 per cent, and pain of a non-colicky character, in 28 per cent. The pain was generalized in 84 per cent, whereas in 14 per cent its site was low in the abdomen.

Altered bowel function was characterized by obstruction in 70 per cent. The same percentage of patients complained of constipation, whereas diarrhea was found in 28 per cent, and the stools contained gross blood in 56 per cent. The average duration of symptoms was 10.2 months, the shortest three months, and the longest twenty-four months. The average loss of weight was 13 pounds, and 70 per cent of the patients had a palpable mass. Fifty-six per cent of this group complained of weakness and showed anemia. All patients complained of three or four symptoms on admission.

A correct roentgenologic and clinical diagnosis was made in 86 per cent.

Six patients were operated on, and all had combined abdominoperineal resections. In one patient the roentgenologic examination was moderately unsatisfactory. No conclusive evidence of organic disease was found. Operation revealed an indurated nodule in the rectum approximately 2 cm. in diameter, with nodules on the surface of the liver. The pathological diagnosis was adenocarcinoma of the rectum.

SUMMARY

The clinical features, diagnosis, and treatment of carcinoma of the colon and rectum have been discussed for each anatomical location. Although the roentgenologic diagnosis was in error in a small percentage of cases, the examination in most instances showed the presence of a lesion and indicated its location to the clinician.

CONCLUSIONS

This study revealed that the cardinal evidence of carcinoma of the colon and rectum is abdominal cramps or colicky pain, or pain of a non-colicky nature, associated with altered bowel function, in a person who has been ill for approximately eight months, frequently with anemia, weakness, loss of weight, and a palpable tumor.

A careful routine manual and exacting proctosigmoidoscopic examination will reveal almost all of the carcinomas of the rectum and sigmoid, and lesions proximal to the rectosigmoid can be accurately diagnosed in the majority of cases by a competent roentgenologic examination.

The surgical treatment is fairly well standardized for each location and will depend upon the extent of the disease, as well as the skill and experience of the surgeon.

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Results of Treatment of 173 Cases of Carcinoma of the Rectum[1]

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EIGHT PER CENT of all cancers are in the large bowel and one-half of these are in the rectum. Unfortunately, a high percentage of the latter are inoperable when first seen, from 20 to 81 per cent of the total number of cases, according to various authors (1–4), with an average of about 60 per cent. Thus many cases are beyond the aid of surgery except for palliative measures, such as colostomy. (It is interesting to note that the latter procedure does not seem to prolong life if all the cases are considered.) Recently, however, with improved technic, the number of cases considered operable has increased considerably in experienced hands (1, 4, 8).

It is generally accepted that surgery is the method of choice in rectal carcinoma, despite the fact that results are far from desirable. Rankin and Graham (5) report that less than 50 per cent of the patients who survive operation will survive the subsequent five years. Daland, Welch, and Nathanson (7) report 41 per cent five-year survivals among those with postoperative recovery, and only 30 per cent among all those operated upon. Early metastasis, as shown by the high percentage of cases (68 per cent) with regional lymph node lesions at the time of surgery (6) probably accounts for this. The improved operative methods now employed in the disease should be reflected in an improved survival rate, but this will probably be more than compensated for by the fact that increasing numbers of patients who previously would have been considered inoperable are now coming to surgery. Thus the operative mortality may be expected to rise and the five-year survival rate of the surgical cases to fall, though the absolute number of survivors will increase, as will the survival rate based upon total cases, operable and inoperable (8). Interestingly enough, Shedden reports a drop in operative mortality from 19 per cent in 83 consecutive cases when his operability rate was 64 per cent to 4 per cent in the next 83 consecutive cases, of which 81 per cent were considered operable.

Where surgery is not feasible, irradiation and electrocoagulation have been the modes of therapy. Irradiation is generally considered to be purely palliative. On the other hand, Schreiner (9) reports 8 cases of inoperable carcinoma of the rectum with survivals of five to thirteen years, with no evidence of recurrence, following radiotherapy. He recommends external irradiation followed by implantation of the residual tumor with radon seeds. Bowing and Fricke (10) report 211 cases treated with radium and roentgen therapy with 8 five-year survivals (4 per cent). They also treated 77 cases with radium alone, with 1 patient surviving five years. Roentgen therapy alone was given to 9 patients, none of whom was alive after five years. Gordon-Watson and Dukes (13) state that an early growth may be destroyed by irradiation with restoration of normal appearance and caliber of the rectum; large, fixed, inoperable growths may be destroyed with resulting fibrous scar; and an inoperable lesion may be rendered operable. Gordon-Watson reports 5 inoperable cases with survivals of five years or more. He warns, however, that though some cures can be obtained by irradiation without sur-

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gery, in early cases it is not to be recommended, as the results are too uncertain.

In a series of 32 cases treated with 1,000-kv. technic, Phillips (8) reported disappearance of the primary tumor in 11. In 3 more cases it disappeared following additional measures (radium in one, diathermy in another, and perineal resection in the third). Twelve patients died in less than a year The treatments were too recent for five-year survival rates.

Our series of patients receiving radiation therapy numbers 173. One hundred seventeen of these were males and 56 females. The average age was fifty-seven years, while the median age was fifty-six. One hundred and four patients had no surgery, or simply a colostomy. This group is made up of the inoperable cases plus 12 operable patients who refused surgery.

TABLE I: AGE INCIDENCE OF 173 CASES OF RECTAL CARCINOMA

Age	No. of Cases
31–35	5
36–40	9
41–45	21
46–50	20
51–55	27
56–60	23
61–65	23
66–70	22
71–75	18
76–80	3
81–85	2

The remainder had surgical treatment in addition to the radiation. Five of this group were at first considered inoperable, but improved under irradiation to such an extent that the lesion was later regarded as operable. In one of these patients the neoplasm had infiltrated the bladder. The lesion shrank considerably following radiation therapy and two months later the tumor was removed surgically. Death occurred twelve years later, of pernicious anemia, without any evidence of recurrence.

The surgical procedure used in recent years has been the one-stage combined abdominoperineal resection of Miles.

Preoperative or postoperative irradiation has not been a part of the routine treatment for operable cases of carcinoma of the rectum in this hospital. The surgical cases which did receive radiation therapy were selected for it by the surgeons because of the impossibility of complete removal of the tumor or the presence of metastases, local or distant.

Table II shows the number of surgical cases given radiation therapy each year and the length of life of each patient from the beginning of treatment. In 1926, for example, 3 surgical cases were treated by irradiation. Only one patient survived more than one year, and he lived more than four years but less than five years. The other two died in less than one year. In 1928 four patients were treated. One died within a year, another lived more than five years but less than six years. The third lived more than twelve years but less than thirteen years. The fourth patient is still living and in good health as of the end of this study (Jan. 1, 1943). (An asterisk indicates that the patient is living.) There was a total of 69 cases in this series, of which 50 were treated more than five years ago. One patient was in the terminal stages of the disease and died before the radiation therapy was completed. Seventeen, or 34 per cent, survived more than five years.

The non-operated group (Table III) totals 104 cases, including the 12 patients who were considered operable but refused surgery. Eighty-two patients were treated more than five years ago. Two of this number were in the terminal stages of the disease, one of these receiving but one x-ray treatment before death. Four patients survived more than five years; 1 of these four is living and well; 2 died of "heart trouble," and the cause of death of the other was not ascertained. Of the 12 patients with operable cancers who refused surgery, none lived more than five years. The five-year survival rate of the non-operated group is 5 per cent.

In 74 of the non-operated group, microscopic examinations were done. Two of these were negative, due to the fact that unsatisfactory specimens were obtained. Both patients died of carcinoma within the subsequent eighteen months. Five of the

TABLE II: SURVIVAL IN YEARS: 69 OPERATED CASES

Year	No. of Cases	1 Yr.	2 Yr.	3 Yr.	4 Yr.	5 Yr.	6 Yr.	7 Yr.	8 Yr.	9 Yr.	10 Yr.	11 Yr.	12 Yr.	13 Yr.
1926	3	1	1	1	1									
1927	3	2	1	1	1									
1928	4	3	3	3	3	3	2	2	2	2	2	2	2	1*
1929	3	2	1	1	1	1								
1930	4	2	1	1										
1931	5	5	4	4	4	4	4	4	3	3	3	3*		
1932	12	8	6	5	4	4	3	2	2	2	2*			
1933	5	1	1	1	1	1								
1934	4	2	1	1	1	1	1	1	1*					
1935	3	3	3	3	3	3	3	1, 1*						
1936	2	1												
1937	2	1												
1938	1	1	1	1										
1939	4	2	1	1*										
1940	5	3	2*											
1941	4	2*												
1942	5*													
Total	69	64	60	55	51	50	48	46	43	39	34	22	17	13
Survival		39	26	23	19	17	13	11	8	7	7	5	2	1
% Survival		61	43	42	37	34	27	24	19					

* Patient living

TABLE III: SURVIVAL IN YEARS: 104 NON-OPERATED CASES

Year	No. of Cases	1 Yr.	2 Yr.	3 Yr.	4 Yr.	5 Yr.	6 Yr.	7 Yr.	8 Yr.	9 Yr.	10 Yr.	11 Yr.
1926	4	3	1									
1927	1											
1928	3	2	1	1	1							
1929	6											
1930	11	5	2	2	1	1						
1931	8	8	2	1	1	1	1					
1932	18	4	1	1								
1933	16	6	3	3	2	2	1	1	1	1*		
1934	9	6	1									
1935	5	2										
1936	1	1										
1937	0											
1938	3	3	1									
1939	7	3	3									
1940	5	3	2									
1941	5	2*										
1942	1, 1*											
Total	104	102	97	92	85	82	82	81	76	67	51	33
Survival		48	17	8	5	4	2	1	1	1	0	0
% Survival		47	18	9	6	5	2					

* Patient living.

tumors were squamous-cell carcinomas and the remainder were adenocarcinomas. Not included in this series was the case of an eleven-year-old boy who had a highly malignant neoplasm, considered finally to be sarcomatous. Another patient not included in the series was believed at biopsy to have a squamous-cell carcinoma but it proved postmortem to be a malignant melanoma. Biopsy was done in all of the patients surviving five years. One of these had a squamous-cell carcinoma, the remainder adenocarcinomas.

The average time from the onset of symptoms to the start of treatment in the non-operated group was 10.5 months, while the median was 8.0 months. The average interval from the beginning of treatment to death or, for the patients who are still living, to the close of this study (Jan. 1, 1943) was 17.0 months; the median was 10.1 months. The average time from the onset of symptoms to death or to the close of the study was 27.5 months, the median 21.0 months.

These statistics are of interest when

TABLE IV: COMPARISON OF RESULTS IN AUTHORS' SERIES AND SERIES OF DALAND, WELCH, AND NATHANSON (7)

	Series of Daland, Welch, and Nathanson				Authors' Non-Operated Series*
	Untreated	Colostomy	Colostomy and X-Ray	Resection	
Onset to death					
Average	17.2 mo.	16.8 mo.	18.80 mo.	....	27.5 mo.
Median	14 mo.	14+ mo.	15+ mo.	27 mo.	21.0 mo.
Onset to treatment					
Average	....	10.8 mo.	9.3 mo.	8.7 mo.	10.5 mo.
Median	....	7 mo.	7 mo.	8 mo.	8.0 mo.
Treatment to death					
Average	....	6 mo.	9.5 mo.	....	17.0 mo.
Median	....	5 mo.	8 mo.	22 mo.	10.1 mo.
Operative mortality		12.5%		26.2%	
Five-year survivals				30%	5%

* X-ray and radium therapy, with colostomy in some cases.

compared with those compiled by Daland, Welch, and Nathanson (7), who found that the average length of life in patients with carcinoma of the rectum who are untreated is 17.2 months from the onset of symptoms, while the median is 14.0 months. They showed further that colostomy has no effect on the life expectancy of this group. The maximum length of life from the onset of symptoms was found to be 4.0 years. (One patient who had a colostomy lived 4.5 years after the onset of symptoms.) Interestingly enough, the maximum length of life for their patients who had a colostomy and x-ray therapy was 3.75 years from the onset of symptoms (Table IV).

Four patients in our total series of 173 cases could not be traced after varying periods of time. In these instances it was assumed for statistical purposes that they died soon after their last visit. As they compose but 2.3 per cent of the series, the effect on the study is insignificant.

The method of treatment used for the patients included in this study has varied greatly. At first only a few x-ray treatments, with a relatively low total dose, were given with 200-kv. radiation filtered with 1 mm. Cu (H.V.L. 1.7 mm. Cu). Gradually the dose was increased up to 3,000 tissue r to the region of the tumor given over a period of twenty-eight days. After July 1938, 220-kv. radiation was employed, with a half value layer of 1.9 mm. Cu. At the present time 400 kv. and a Thoraeus filter of 0.44 mm. tin plus 0.25 mm. copper and 1.0 mm. aluminum are being used (H.V.L. 4.0 mm. Cu.). The target skin distance is 70 to 80 cm. The treatments are delivered in divided doses through five ports: a single broad posterior, two anterior oblique, and two lateral ports. Usually only one port is irradiated each day with 300 r (air). The treatments are given daily except Sundays and extend over a period of about twenty-eight days.

Local γ-ray therapy is usually given upon the conclusion of the external irradiation. Some patients in the reported series, however, were in too poor condition for such treatments; some were treated for metastatic lesions which could not be easily reached with radium or radon applicators, and some of the operated patients received γ-ray therapy beforehand, from radon tubes inserted at the time of surgery. Otherwise γ-ray therapy is given immediately following the x-ray series to the remnants of the tumor, by means of tandem radium tubes placed in the rectum or radon gold implants inserted around the lesion or, most often, by a combination of these two procedures. No radical change in this method has been made since 1926, but the dose has been increased slightly. It is difficult to estimate the tissue dose, since the implants cannot be accurately spaced by the surgeon and there is some uncertainty concerning the size of the tumor. The calculations are made for 7,000 γ-ray roentgens as a minimum, but it is possible that some of the tumor cells extend beyond the zone receiving this amount. When it is pos-

sible to insert tandem radium tubes in the lumen, this is done previously to the implantation in such a manner that the whole length of the tumor is exposed rather evenly to the gamma radiation. At least 0.5 mm. platinum filter is used. The diameter of the tubes usually has to be kept at a minimum for annular lesions but, if the tumor is limited to one-half or less of the circumference, it may be possible to use a rectal bougie and place some lead behind the radium in order to reduce the exposure of the healthy mucosa. The type of applicator is selected to suit the individual case. Usually 2,000 to 4,000 mg. hr. are applied in this manner in a period of twenty to fifty hours.

SUMMARY

One hundred and seventy-three cases of carcinoma of the rectum were given radiation therapy; 69 of these were treated surgically (for cure), while 104 had no operation or merely a colostomy. The surgical cases were selected for irradiation because of their poor prognosis due to the impossibility of complete tumor removal or the presence of metastases or recurrences. Five of the surgical cases were considered inoperable at first, but the tumor in these cases shrank following irradiation, and the patients were later operated upon.

Of patients treated by surgery (for cure) plus irradiation, 34 per cent survived five years or more. Of those without surgery, or merely a colostomy, 5 per cent survived five years or more.

The mean life expectancy of carcinoma of the rectum (untreated) from the time of onset of symptoms to death has been reported to be fourteen months. In our series the patients who were treated by irradiation, without operation, had a mean length of life of twenty-one months.

CONCLUSIONS

Adequate irradiation of carcinoma of the rectum is more than merely palliative. It increases life expectancy appreciably. In some cases inoperable tumors become amenable to surgery. In a small percentage of cases cures are effected by irradiation.

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Aseptic Necrosis in Adults: Caisson Workers and Others[1]

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ROENTGEN examinations of persons who have worked in compressed air, some with a history of bends, or caisson disease, have revealed either single or multiple infarcts in the shafts of long bones, with and without intra-articular areas of aseptic necrosis. The extra-articular bone changes have been found chiefly in the ends of the shaft, either the cancellous or medullary portion, or both. The middle third of the shaft is less frequently involved. Exactly similar changes have been seen in persons—including several women—who have never worked in tunnels or under compressed air and have never been subjected to violent changes in atmospheric pressure.

Textbooks describe caisson disease as an acute condition appearing in workers under increased atmospheric pressure, as a result of too rapid decompression. Synonymous terms are bends, diver's palsy, chokes, and staggers. Armstrong introduced the term aero-embolism to describe the condition. Fulton termed it decompression sickness; Hankwitz, decompressed-air illness; End, compressed-air illness; Henderson, aero-emphysema. Musser defines caisson disease as "the disease of caisson workers and divers caused by too rapid decompression, following exposure to increased pressure." Aviators may also be included, since the swift decrease of atmospheric pressure during ascent is the equivalent of a rapid decompression, except that, quantitatively, nitrogen saturation at 1 atmosphere is considerably less than at increased pressures. Aero-embolism is not to be confused with anoxia.

Kahlstrom, Burton, and Phemister state that "caisson disease is the result of injury to the tissues by nitrogen bubbles liberated when the body, which in compressed air has absorbed an excess of nitrogen, is too rapidly removed from the decompression chamber." They indicate that "chronic lesions sometimes result from caisson disease, the most important being impairment of hearing, paralysis from spinal cord damage, and disturbances of the bones and joints." They credit Bornstein and Plate (1911) and Bassoe as being the first to describe joint lesions in caisson disease. Bassoe also observed lesions in cancellous bone remote from joints in 3 cases. According to Behnke, bone changes have not been observed in deep-sea divers.

Air is composed of approximately 20.9 per cent oxygen, 78 per cent nitrogen, 0.04 per cent carbon dioxide, and 1 per cent of inert gases. According to Boyle's law, a given mass of gas varies inversely as the pressure, the temperature being constant; as the pressure rises, the volume decreases, and *vice versa*. When a person is subjected to increasing atmospheric pressures, the absorption of gases is increased. All tissues absorb and act as a solvent for nitrogen, but its solubility is greatest in the fats and lipoids, which are capable of holding five times as much in solution as the non-fatty tissues. The solubility of nitrogen within the tissues increases as the pressure rises, with a time factor necessary for saturation.

To quote Musser: "According to Dalton's law, gases are soluble in fluids according to their partial pressures. At 4 atmospheres, therefore, the plasma leaving the lungs holds four times as much nitrogen as under normal atmospheric conditions. The tissues in turn become saturated at the new level at a rate which varies with the particular ability of the tissue to absorb the gas and with the adequacy of the circulation to bring nitrogen to the part. Fat, which absorbs about five times as much nitrogen as water, is saturated slowly. Ligaments, bones, and the white matter of the spinal cord attain a new

[1] Accepted for publication in August 1943.

equilibrium more gradually because of the limited blood supply. Even with the increased circulation rate consequent upon manual work, several hours may elapse before the entire body is saturated at the new level."

To release the gases which have gone into solution under increased atmospheric pressure, without producing symptoms, requires a gradual reduction to normal pressure. With slow decompression there is a gradual release of the nitrogen in solution, which escapes with respiration, causing no physical disturbances. The period required for decompression depends upon the pressure and the time spent working under that pressure.[2] End writes: "According to standard United States Navy decompression tables, a diver who descends to a depth of 250 feet and remains there for 20 minutes must spend 2 hours and 26 minutes in decompression. Should he extend his stay on the bottom 10 minutes longer, his decompression time will increase by more than an hour." When decompression is too rapid, there is a sudden release of nitrogen from the tissues into a gaseous state, causing the physical disturbances of caisson disease. The same occurs when there is a sudden reduction in pressure from 1 atmosphere to a small fraction thereof. To overcome these symptoms, it is necessary to return to a greater atmospheric pressure, permitting the nitrogen to change from the gaseous to a liquid state in the body fluids and tissues. The inhalation of helium-oxygen mixtures before and during decompression has been suggested as a prophylactic measure. Helium is only half as soluble as nitrogen and three times as diffusible, with the result that the gas is eliminated more rapidly during decompression. In aviators symptoms dependent upon disturbances in the equilibrium of gases in the blood and tissues at higher altitudes can be prevented, to a certain extent, by breathing oxygen for a predetermined length of time prior to or during ascent.

[2] Decompression tables are available; also Regulations of the N. Y. State Dept. of Labor.

Musser claims that "there is little or no danger at pressures less than 15 pounds above normal atmospheric conditions, no matter how rapidly the decompression is accomplished." He also states that "exposure for short intervals, even to extremely high pressure, is not followed by accidents. For this reason, naked deep-sea divers have little or no difficulty, because they remain under water for only two or three minutes. In the caissons of the St. Louis Bridge Company no cases of bends occurred among many visitors, although of 352 employees, 12 were killed and 18 were seriously injured by caisson disease."

Meakins states: "If the decompression is not done properly, bubbles of nitrogen will form in the tissues, the capillaries and small veins and venules. These will be particularly prominent in the fat deposits, white matter of the central nervous system of the brain and nerves, and other tissues where the saturation is high, or the blood flow is slow."

ANATOMY

Infarcts have been demonstrated in the long bones, with the exception of the ulna, clavicle, and tubular bones of the hands and feet. The long bones have a tubular marrow cavity containing yellow marrow, rich in fat. The upper ends of the humerus and femur, on the other hand, as well as the short bones (vertebrae, carpals, tarsals, patellae, hyoid, and sesamoids) and the flat bones (sternum, scapulae, innominate, ribs, mandible, and most of the skull bones) contain red marrow. With advancing age, there is a partial replacement of the red marrow by yellow marrow even in the ribs and sternum.

The marrow cavities of the long bones are lined by a highly vascular areolar tissue called the medullary membrane, or endosteum, which functions as an internal periosteum and as an envelope for the contents of the medullary cavity.

There are three sources of blood supply to the long bones:

1. The periosteal vascular system.

Fig. 1. J. C., white male, age 60, had a single exposure to compressed air 35 years ago, followed by an attack of the bends. Bone infarcts with reparative changes are present in the femoral and tibial shafts. There is no involvement of any of the articulations.

2. The system of irregular vessels supplying the ends of the long bones—the articulations. Apertures in the articular cartilages permit vessels to enter, perforate the cortex, and pass into the spongiosa. These vessels supply the epiphyses.

3. The nutrient artery, which divides into branches going to either end of the bone. These branches divide repeatedly, and their terminal ramifications do one of three things. (*a*) They may anastomose with branches of the periosteal vessels. (*b*) They may anastomose with branches of the irregular vessels at the ends of the bones (in the epiphyses). (*c*) If the epiphyseal cartilage is present, they do not enter the epiphyses, but may form loops and join the venous system. The various circulations thus mingle with one another by means of abundant anastomoses.

The venous drainage follows the arterial supply. The nerves accompany the nutrient artery into the interior of the bone and are distributed freely to the periosteum. They are most numerous in the articular extremities of the long bones, in the vertebrae, and in the larger bones.

The concept of "end arteries" has been invoked rather frequently in connection with bone infarction. The term "end artery" was coined by Cohnheim to designate a particular type of arterial circulation in the tissues. Actually there is only one true end artery, the central artery of the retina. When this is blocked, no collateral circulation develops. Viscera are said to have an end-arterial type of circulation when an inadequate anastomotic circulation develops, followed by infarction. The brain, heart, kidneys, and spleen are the viscera accused of possessing an end-arterial circulation, and they are prone to infarction. Under special conditions, infarction may also occur in the intestines, lungs, and liver.

ROENTGEN APPEARANCE

Bone infarcts are usually limited either to one or both ends of a long bone, but more than one bone may be involved. The lower extremities are the more usual site. In caisson workers, the lesions as a rule are extensive, multiple, and often bilateral. In some cases, they are limited to either the proximal or distal end of the medullary cavity or both, or to one or both

diaphyseal ends. In other cases, they are limited to the spongy bone in the epiphyseal end or, again, they may involve both the medullary cavity and the contiguous spongy bone of the diaphyseal and epiphyseal ends. When the epiphyseal end of the bone is involved, the articular cartilage may participate in the lesion. Involvement of the central portion of the shaft is infrequent. In the shaft, the lesion appears as an irregular area of altered or decreased density, sometimes, but not always, surrounded by a thin, linear area of increased density, representing a partial re-ossification. Linear strands of ossification may project from the periphery into the area of decreased density in one or more places for variable distances. Also, there may be an increase in density depending upon the extent of the reparative changes. The lesion is limited to the medullary portion of the bone and does not encroach upon the cortex. The area of altered density in the medullary cavity may extend into the spongy diaphysis. When the epiphyseal end of the bone and articular cartilage are involved, the articulating surface may or may not present an irregularity in contour; often it shows an alteration in shape. Infractions or sequestrations or areas of aseptic necrosis may be present. The end of the bone may be of uneven density; it may show fibrocystic changes, with intervening areas of increased bone density or sclerosis. The joint space may be narrowed and partially destroyed. Productive changes may develop at the articular margins, identical in appearance with hypertrophic osteoarthritis.

When the hip is involved, the head of the femur may be flattened and enlarged. Fibrocystic and sclerotic changes may involve the head of the femur as well as the acetabular shelf. Infractions and sequestrations may be present. Marginal osteophytes and joint bodies may develop. Evidences of decalcification and softening may be seen.

Fig. 2. T. P., white male, age 46, gave a history of exposure to compressed air for 20 years but denied any attacks of the bends. Bone infarcts and reparative changes are present in the long bones of the lower extremities. The hip joints show evidences of aseptic necrosis. (Shoulders also show evidences of aseptic necrosis.)

In the shoulder, the changes are essentially limited to the head of the humerus. There are evidences of softening, irregularity in contour, and aseptic necrosis. The head of the humerus does not always enlarge. Joint bodies may de-

velop. The contiguous portion of the shaft may also be involved.

If the lesion in the shaft is small and limited to the diaphyseal end of the bone, it may gradually be replaced by new bone and disappear completely. If the lesion is in the epiphyseal end of the bone and subsequently borders on the joint, secondary hypertrophic osteoarthritic changes ensue.

The linear area of increased density surrounding the shaft lesion is evidence of a reparative process, a healing phase, and has been described by Phemister as a creeping substitution. This creeping substitution decreases the size of the area of altered or diminished density, *i.e.*, the area of infarction. Eventually this process of replacement, which is never complete in the larger lesions, slows down and ceases. Irregular calcification in the interior may occur. These areas may now be described as being encapsulated by a narrow zone of calcification and ossification. The smaller lesions may be completely replaced by bone. In the non-caisson worker, where the lesion is single and not extensive, the reparative changes are usually greater.

Fig. 3. J. J., white male, age 35, gave a history of exposure to compressed air for 10 years with several attacks of the bends. The right humerus, right radius, and femora show infarcts with reparative bone changes. The articular portions of the right humerus and left femoral head show joint changes.

These bone changes are the result of an interference with the blood supply to the part, produced by an occlusion of the vessel either from within or without, or both. That portion of the bone supplied

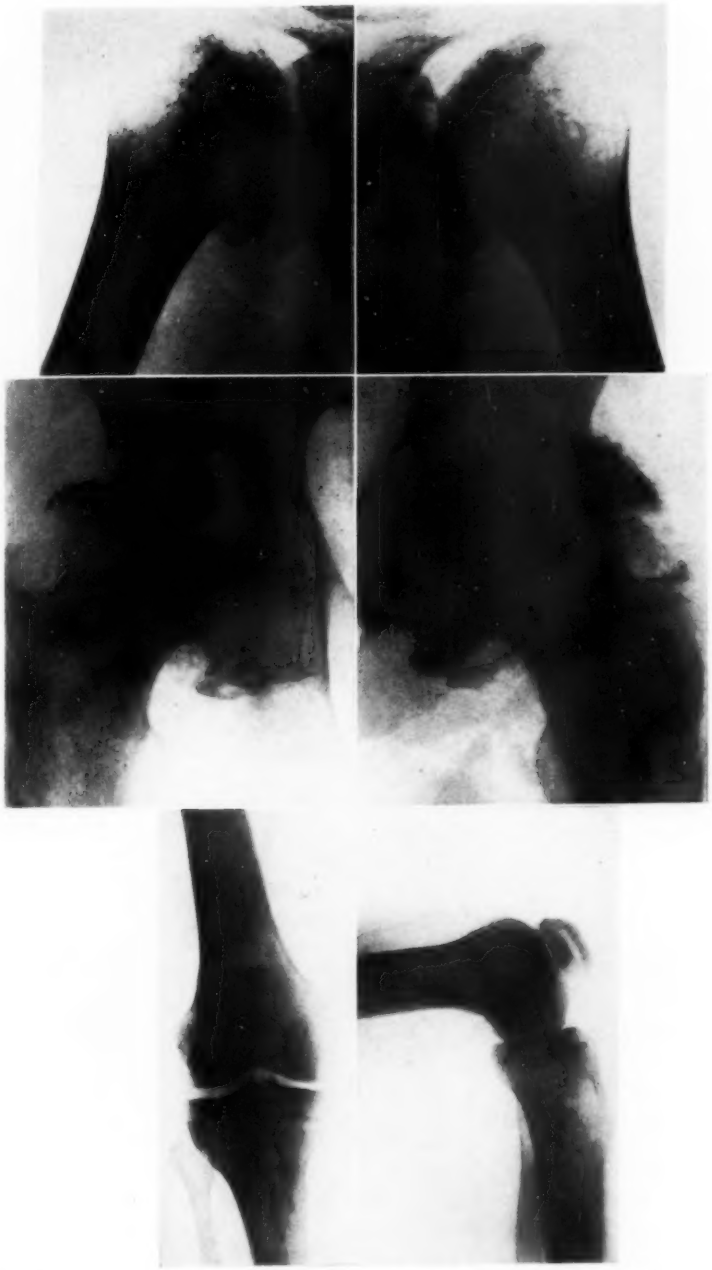

Fig. 4. C. W., colored male, age 56, was exposed to compressed air for 2 years but discontinued his occupation of sandhog 35 years ago because of one attack of the bends. He complains of pains in the hips, with limitation of motion. Shoulders and hips show extensive arthritic changes not unlike those of hypertrophic osteoarthritis, but there are no symptoms referable to the shoulders. Infarcts with reparative changes are observed in the upper ends of the shafts of the humeri, lower ends of the femora, and upper ends of the tibial shafts.

by the occluded vessel becomes ischemic and dies, and the result is a bone infarct or an area of aseptic necrosis. In caisson workers, the contention is that nitrogen in a gaseous state, producing either an embolus or a pressure effect upon the blood vessel, or both, is responsible. The lesions in non-caisson workers are usually neither as extensive nor as numerous, and the etiologic factor is unknown. Many possibilities have been suggested: fat emboli, bland infarcts, septic foci, peripheral vascular disease, etc.

The roentgenologic aspects of caisson disease were recently brought to the fore by Ross Golden's book, "Diagnostic Radiology." Hodges, Phemister, and Brunschwig, the authors of the section on bone diseases, presented roentgenograms of two cases in men who had worked in tunnels under increased pressure and had suffered attacks of the bends. The skeletal changes were related causally to the occupations and diagnosed as caisson disease in bone. In February 1939, Kahlstrom, Burton, and Phemister reported 4 cases of aseptic necrosis of bone occurring in men working under increased pressures, and in March they added 3 cases of undetermined etiology in persons who had not worked under increased pressures and who gave no history of the bends. Several articles have subsequently appeared dealing with caisson disease in bone. Coley and Moore reported two cases, accidental findings in cancer patients. Rendich and Harrington published four cases. Walker recorded a case discovered incidentally in an alcoholic who had been injured. Recently, L'Episcopo discussed this subject at the New York Academy of Medicine, and Bell, Edson, and Hornick published an article dealing with the bone and joint changes in compressed air workers without symptoms.

At the Goldwater Memorial Hospital, I have found aseptic necrosis in the joints of both males and females and have encountered, as accidental findings, asymptomatic bone infarcts, or altered bone densities, in the shafts of long bones of patients who have never been exposed to increased atmospheric pressures. My first experience was in the latter part of 1939, when I observed, in the lower end of a femur, a large irregular area of decreased density, surrounded by a zone of calcification, closely resembling one which had recently been described as caisson disease. Investigation failed to disclose an occupational history or any other etiological factor to account for the roentgen findings. Since then I have collected a series of shaft and joint lesions in 41 patients, identical in appearance in many instances with those described as caisson disease. In no instance was there a history of work under compressed air or of subjection to sudden and violent changes in atmospheric pressure. In March 1942, Kahlstrom reported bone infarcts in 4 persons who were not exposed to increased atmospheric pressures, 3 of whom had arteriosclerosis.

The earlier of the two articles by Kahlstrom, Burton and Phemister, cited above, is most illuminating and comprehensive, recording the many phases of bone infarction. These writers were fortunate in obtaining a postmortem examination in one case, a biopsy in a second, and the opportunity of studying the excised head of the right femur in a third. All of the patients in this series were tunnel workers, with definite histories of the bends. Because of the history, the bone changes were believed to be related etiologically to the occupation. In the 3 cases presented by these same authors in their second paper, in patients who had not worked under increased pressures and had no history of the bends, identical roentgen findings were observed. A biopsy was obtained in one case, and the microscopic findings were also identical with those observed in the series previously described. The only differentiating point between the two series was the occupational history. There was no obvious uniform cause for the findings in the second group. In the absence of any explanation for the areas of infarction in these cases, there is always the possibility that bone infarcts in men working under compressed air may have antedated the occupation

Fig. 5. L. L., white female, age 46, was an acrobatic dancer as a girl. She gave a history of fracture of the right femur in 1927 and surgery for nonunion one year later. Reconstruction operations were done on the hip joints for traumatic osteoarthritis in 1930. Wound infection and osteomyelitis developed on the left side, and a draining sinus still persists. The patient is bedridden. The shoulders show evidences of aseptic necrosis. In the femoral and tibial shafts are infarcts with reparative bone changes.

and may bear no relation to it. This possibility cannot be excluded.

AERO-EMBOLISM

The air embolism theory of bone infarction presupposes a sudden change in atmospheric pressure, due in caisson workers to improper decompression, with at least one and perhaps more than one attack of caisson disease. This would be logical if all tunnel workers with bone changes had experienced one or more attacks of the bends. Actually, this is not so. Recently Bell, Edson, and Hornick made a roentgen survey of 32 tunnel workers who were free of symptoms referable to the joints and long bones. Twenty-four showed bone changes. Their employment as tunnel workers varied from three to thirty-three years, with periods of continuous employment under compressed air for as long as thirty months and in no case less than ten months. Of the series of 32, only 14 admitted to one or more attacks of the bends. Even though the group studied is small, the fact that 18 gave no history of bends makes it obvious that an attack of that condition is not a prerequisite for bone changes. It may be that the attacks of the bends are not responsible for the bone changes at all. Recently, I made a skeletal roentgen examination of a caisson worker who, during an exposure to increased pressures for over eight years, admitted to 12 attacks of bends of varying severity. No bone or joint changes were demonstrable.

Phemister refers to the work of Dr. C. Howard Hatcher, who "produced caisson disease experimentally in dogs, but in no instance was infarction found." Phemister himself attempted to produce bone necrosis by means of arterial air embolism in dogs. He injected varying amounts of air, 6.7 to 12. c.c. per kilogram body weight, in 7 dogs. One dog died in ten minutes, and a second over night. A third showed no symptoms and was destroyed in 94 days. Four dogs had paralyses in the hind legs; of these, one died in seven days, a second in eight days (from wound infection), a third (from distemper) in 78 days, and the fourth was sacrificed after 155 days. No bone changes were observed in the five dogs which survived air injection. Phemister says: "The absence of necrosis in the bones of the 4 dogs whose hind limbs were partly or completely paralyzed by the air embolism may possibly be considered as evidence favoring the view that the bone lesions in caisson disease are rather due to gas liberated in the medullary cavity under sufficient pressure to asphyxiate the tissues than the embolism."

Edgar End refers to the work of Swindle and mentions "the constant finding of a marked state of agglutinization of erythrocytes in experimental animals subjected to compressed air illness." He does not discuss this except to say: "... it can be stated at this time that agglutination of erythrocytes appears to be the primary disturbance in compressed air illness and that bubble formation may be looked upon as a serious complicating factor. Of practical significance in this connection is the observation that alkalinization apparently influences this condition favorably, which has led us to employ the ingestion of sodium bicarbonate as a prophylactic against compressed air illness during experimental deep dives."

Behnke, working with anesthetized dogs rapidly transferred from high to low pressures, makes the following statement: "The most remarkable finding, however, was the occurrence of *hemoconcentration* shown by increased oxygen capacity of the blood. . . . The blood, moreover, was difficult to withdraw because of the tendency to clot. In histologic sections of the lungs, cell packing in blood vessels was prominent. Agglutination was not observed."

All of this suggests two questions: What effect, if any, is there following an attack of the bends? What is the mechanism in the development of bone and joint changes in compressed air workers? One must accept the theory that the changes described as bone infarcts in the shaft and as aseptic necrosis in the articular portions are the result of an interference with the

circulation. Behnke states that atmospheric pressures varying from 3 pounds per square inch to pressures as high as 215 pounds per square inch are without demonstrable physiologic effect on the body tissues. There is no effect on protoplasm with pressure changes.

What effect, if any, is there following an attack of the bends? A hasty decompression brings forth an attack. There has been a rapid change in atmospheric pressure, with a liberation of those gases in solution in the blood and tissues from a liquid to a gaseous state. This is a physical change and should occur throughout the entire body. The rate of return to a gaseous state varies in different parts of the body and depends upon the solubility within the tissues, the concentration, and the blood supply. From a quantitative standpoint, the liberation will be five times as great from the fatty tissues. The fats and lipoids take up five times as much nitrogen as the non-fatty tissues.

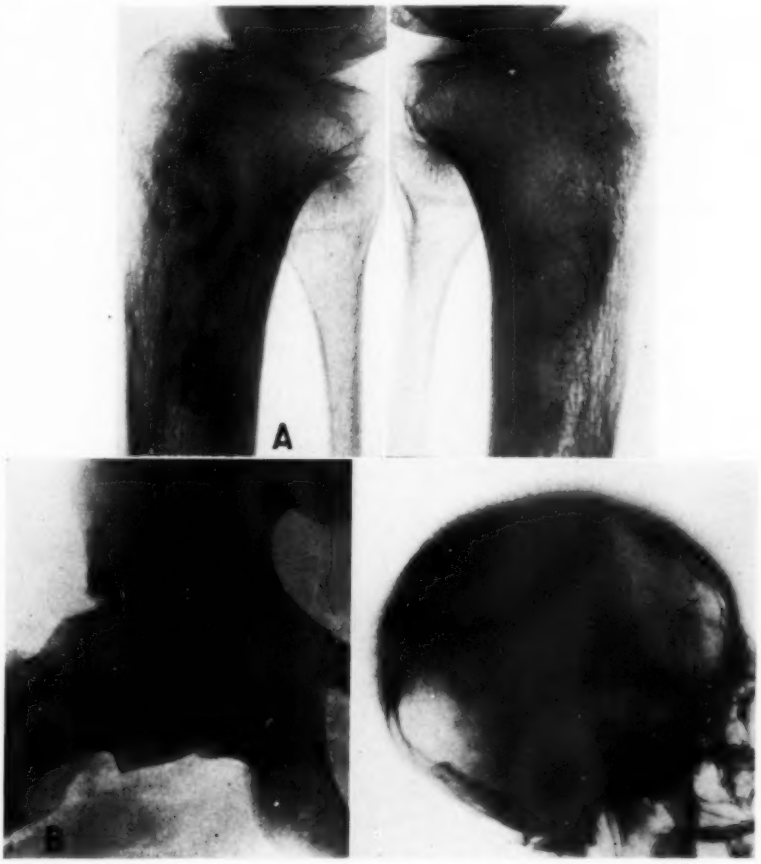

Fig. 6. A. E. C., white male, age 58, had syphilitic heart disease, with a 4-year history of cardiac symptoms and episodes of cardiac failure. He never worked under compressed air. In 1938 he had an attack of rheumatism, affecting all joints, but recovered. Reparative bone changes in the upper ends of the tibiae were accidental findings; there was no pain referable to these areas.

B. J. K., colored male, age 24. The clinical diagnosis in this case was sickle-cell anemia. The patient had rheumatic fever, with a polyarthritis, during the past year. All the joint pains have disappeared. The right hip shows evidences of aseptic necrosis. The skull shows the characteristic changes of sickle-cell anemia.

The large deposits of fats and lipoids are in the abdomen, central nervous system, and yellow marrow, those in the abdomen and abdominal wall exceeding, quantitatively, those in the marrow cavities of the long bones. The liberation of nitrogen in the abdomen and abdominal wall and the expansion of the gases within the stomach and intestinal tract result in severe abdominal pain. When this develops, recompression relieves the symptoms immediately, for the gases in the tissues are returned to a liquid state, and those in the intestinal tract are reduced in volume.

With a slow re-decompression, there is no return of the acute symptoms. If the period between the acute symptoms and second compression is short, there may be no serious circulatory damage. In the obese, ecchymoses in the abdominal wall may be seen. Ecchymoses probably occur, also, in the omentum, and may de-

Fig. 7. A. F. S., white female, age 41, complained of stiffness and weakness in the left thigh, followed by pain in the left hip, in August 1940 and pain in right hip two months later. Occupation: Domestic. Femoral heads show aseptic necrosis.
B. M. H., white female, age 36, had pain and progressive restriction of movements in hip joints for 5 years. She associates her symptoms with the birth of her fourth and last child. The femoral heads show evidences of aseptic necrosis.

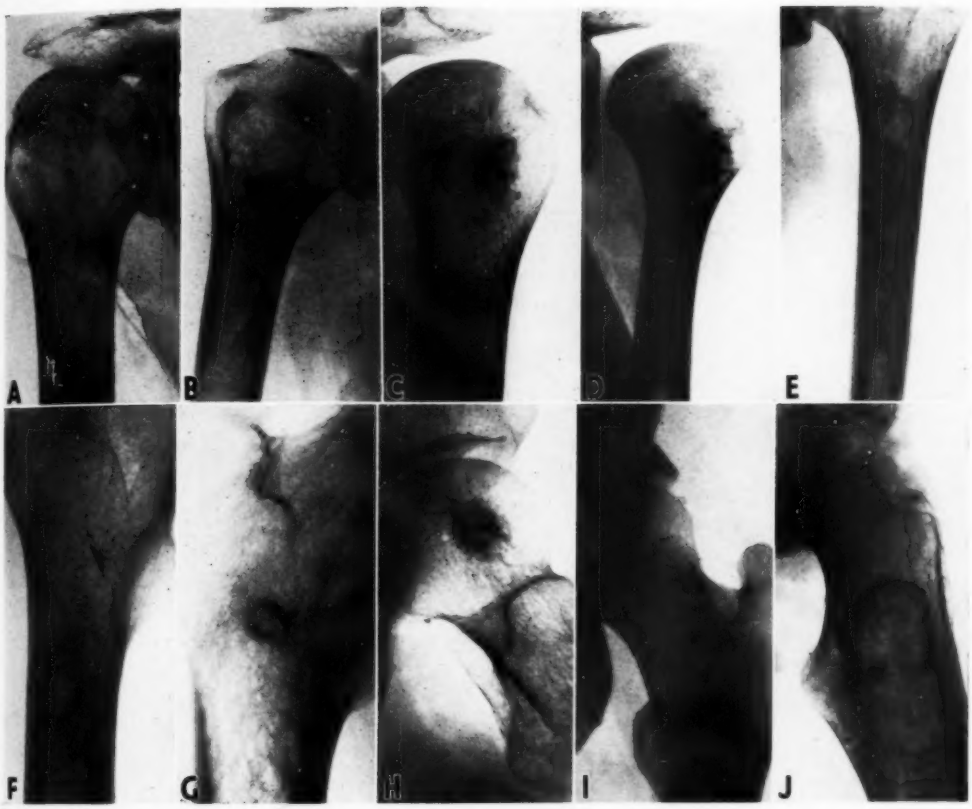

Fig. 8. A. F. McG., white male, age 46, had an astrocytoma of the right cerebellum and had undergone two cranial operations. Intracranial symptoms first appeared in 1924. There are small localized calcifications in the upper end of the humerus. The patient never worked under compressed air.

B. G. W., colored female, age 54, a hospital employee, has a large irregular cystic area of varying density in the upper end of the shaft of the humerus, discovered by accident.

C. T. S., white female, age 30, has progressive pseudo-hypertrophic muscular dystrophy. She never walked normally (only with assistance) and was bedridden at the age of 21. There is a large irregular calcified focus in the upper end of the shaft of the humerus.

D. W. W., white male, age 84, complains of aches and pains in all joints, for many years. Clinical diagnosis: Arteriosclerosis. There is irregular increased density in the upper end of the shaft of the humerus. The patient never worked under increased pressure.

E. H. H., white male, age 68, had peripheral vascular disease; no pulsation in either dorsalis pedis; general arteriosclerosis. Irregular areas of increased density are present in the upper third of the medullary portion of the shaft of the humerus. There is no history of exposure to compressed air.

F. F. M., white male, age 72, had osteoarthritis of the spine and old fractures of the 6th, 7th, 8th, and 9th ribs on the right side; also, syphilis of the central nervous system. There is irregular increased density in the trochanteric area and an area of altered density in the upper portion of the shaft. No history of exposure to compressed air.

G. H. C., white male, age 28, with rheumatoid arthritis, never worked under compressed air. There is a reparative process in the intertrochanteric area.

H. M. H., white female, age 60, had paralysis agitans. There is irregular increased density in the head of the left femur.

I. L. E., white female, age 80, had diabetes mellitus and general arteriosclerosis. A small oval area of decreased density with reparative changes is present in the neck of the left femur.

J. M. H., white female, age 53, had rheumatoid arthritis, pyelonephritis, nephrolithiasis, and varicose ulcers. There is a large oval cystic area with reparative process in the upper end of the shaft of the femur, extending into the intertrochanteric area.

velop in the brain, spinal cord, and fatty marrow. There is no injury to osseous structures. Where the period between the acute symptoms and recompression is prolonged, circulatory damage in soft and osseous tissues may result. It is difficult to evaluate the time factor. Barach, in a discussion of the symptoms of oxygen deficiency, makes the following statement: "The extremities may be deprived of oxygen for periods of an hour and one-half by the complete closure of the arterial blood supply and thereafter may be used with completely normal function." While oxygen deficiency does not enter into the problem here, it is of interest to note that closure of the arterial supply to the extremities for one and one-half hours does not lead to death of the part. When circulatory damage does occur, if the area involved is small, it is probably of no consequence, particularly if it does not involve the brain or spinal cord. In the brain and spinal cord, the changes may be permanent. If the period between the development of symptoms and recompression is unduly prolonged, the results may be disastrous. Those recovering from the acute symptoms return to work within a day or two as if nothing had happened.

As pointed out earlier in this paper, there is an established relationship between the duration of exposure to increased pressure and its degree (30, 40, or 50 pounds) and the time factor necessary for decompression if an attack of caisson disease is to be avoided. In actual practice, the rate of decompression is predetermined and applied to all persons alike. End states: "Unfortunately, decompression according to standard tables will not always prevent compressed air illness. . . ." Theoretically, the decompression should obviate an attack of caisson disease in any given group. For the most part it does, and the majority of workers develop no symptoms. In some, acute symptoms may develop within a comparatively short time after decompression; in others, within a few hours. Still others have no acute symptoms of caisson disease but complain of aches about the joints either shortly after decompression or hours later. The symptoms in all instances are relieved by recompression. The inference must be that both the acute symptoms and the mild or subacute symptoms are caused by the same agent, liberated nitrogen in a gaseous state (or air). It may be safe to assume that an acute attack of caisson disease is the result of a faulty decompression; either the decompression was hastened or it was completely omitted. Delayed or subacute symptoms, on the other hand, cannot be related to faulty decompression.

There is a group of workers, as mentioned above, in whom symptoms develop several hours after a proper and adequate decompression. It is rather difficult to explain why in this group (sandhogs) there should be a delayed reaction to a physical change. Several factors may contribute to this situation. Nitrogen in solution has a narcotic effect. The threshold of irritability in this type of worker is probably high. These workers, furthermore, usually partake of alcohol (contrary to instructions) freely and are probably under its influence a good part of the time. It may be that it is not until the influence of the alcohol and the narcotic effect of the nitrogen have worn off that they become aware of their aches and pains. Clarification of the senses makes for an awareness or intensification of the symptoms.

In the group without an attack of caisson disease, either immediate or delayed, but with aches in and about the joints, one or two possibilities may be considered. There may be a poor anastomosis of vessels in the ends of the bones, or the vessels may be of small caliber, or both. Either would be sufficient to slow the circulation and prevent adequate release of nitrogen locally. Following decompression, a quantity of nitrogen may be trapped in areas where the circulation is slow and poor and where the anastomoses are inadequate. According to Musser, "when the pressure is reduced, the rate of desaturation is irregular, and those parts which acquire nitrogen slowly

tend to retain it. At the end of the period of decompression, such tissues as fat may hold an amount of nitrogen which cannot be immediately dissolved in the blood. Bubbles may thus be formed either in the tissues or in the blood." This usually occurs in the ends of long bones. The gas is confined to a fixed space, its volume increases, exerts pressure, and causes the ache or pain. Gas emboli or external pressure on vessels, or both, may follow a single decompression or possibly as a cumulative effect after repeated decompressions. When the circulatory damage persists, an ischemia and ultimately death of the part follows. The subsequent changes,

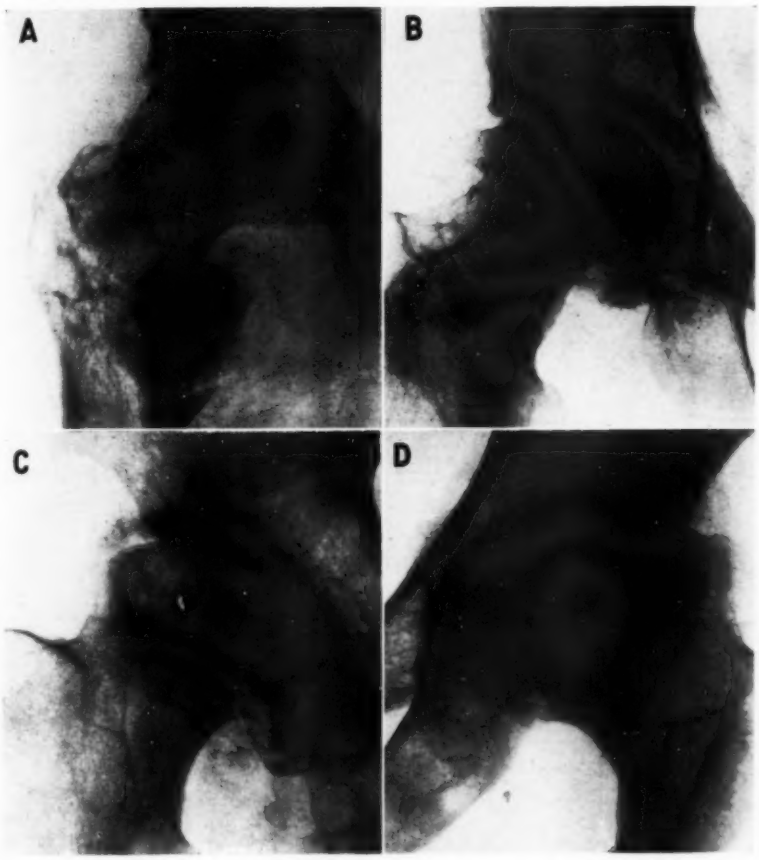

Fig. 9. A. E. C., white male, age 70, had general arteriosclerosis. He sustained an intertrochanteric fracture 3 months prior to present x-ray examination. The head of the femur shows marked increase in density associated with aseptic necrosis. This patient never worked under compressed air.

B. B. C., white male, age 30, gave a history of several years' exposure to compressed air, as a sandhog, with several attacks of the bends. The head of the femur shows an increase in density with no infraction. Reparative bone changes are present in the neck and intertrochanteric area.

C. M. C., white male, age 68, had thrombophlebitis of the right leg in November 1939, followed by pulmonary infarction, with uneventful course. He had varicose veins, osteoarthritis, and arteriosclerosis. The head of the femur shows aseptic necrosis with arthritic changes. No history of exposure to compressed air.

D. J. F., white male, age 38, gave a history of 15 years' exposure to compressed air, with several attacks of bends. There is aseptic necrosis in the head of the left femur; infraction with deformity of head.

apparent on a roentgen film, are described as bone infarcts or aseptic necrosis. They do not develop immediately. A long time is necessary before osseous changes are manifest. In the shafts of the bones reparative changes may appear, as described above. In the joints, various manifestations are possible: aseptic necrosis, infraction, separation, revascularization, softening with deformity following weight bearing, and secondary hypertrophic osteoarthritic changes.

The explanation for the development of the bone and joint changes in caisson workers who have never had an attack of the bends is similar to that given above. This explanation seems tenable to me, since changes occur primarily in the ends of the bones, where the caliber of the blood vessels may be small, the circulation slow, the anastomoses poor, and the marrow red (shoulder and hip). The sites of predilection, in order of frequency, are the head and upper end of the shaft of the femur, the head and upper end of the shaft of the humerus, the lower end of the femur, the upper and lower ends of the tibia and fibula, the lower ends of the humerus and radius. The upper ends of the femur and humerus are most frequently involved. Though these contain red marrow, the circulation is slow, and interference with it results in aseptic necrosis. The changes may be extensive in the long bones, and the same person may show no degenerative changes in the brain or spinal cord. If an acute attack of bends is necessary to produce emboli or occlude blood vessels in the bones, then it ought to do the same thing, at the same time, in other parts of the body, especially the spinal cord. This probably happens in fatal cases, but fortunately these are few.

Because all caisson workers do not develop symptoms or reveal bone changes, the premise is that decompression was inadequate for the one who does develop symptoms or bone changes and not for the group. This being so, the cause for the trouble must lie within the individual. Admitting that there must be a circulatory change to account for the pathological change, what is it that makes this possible? The loose designation of end arteries does not answer the question. There must be individual variations in the circulatory tree, especially as it pertains to the skeleton. The rate of flow must be decreased, and, as pointed out above, this may be the result of small caliber vessels, poor anastomosis, or both.

The ability of any person to absorb gas under increased pressures, and in particular to release gas in solution during decompression, depends upon the size of the blood vessels, the extent of the vascular tree or anastomoses within a given area, and the rate of blood flow. All persons are not so constituted anatomically that they will have blood vessels and anastomoses of the same size or character. Some have larger vessels than others. Some have more adequate anastomoses. When the cross-sectional area of the vascular tree or bed is large, the volume flow per minute is greater. Exercise during decompression also serves to accelerate the blood flow. Because of the variations in the development of the vascular tree, a decompression which would be adequate for a worker with a large cross-sectional area would be inadequate for another with a smaller cross-sectional area. This would account for delayed subacute symptoms, manifesting themselves as aches in and about joints following a so-called adequate decompression. In other words, some persons release the nitrogen in solution at a rate proportionate to the rate of decompression and do not develop acute, delayed, or subacute symptoms, while in a second group the rate of release of the nitrogen lags behind the rate of decompression and excess nitrogen is retained in a gaseous state, usually in the ends of the long bones, producing symptoms. If the decompression could have been prolonged, the probabilities are that these persons would have rid themselves of the residual gas. While, under these conditions, nitrogen is not present in sufficient quantities to produce an actual attack of the bends, it is

trapped in a non-resilient area, where its expansion causes an increase in local pressure, resulting in aches or pains.

ployment, with no record of faulty decompression, and no history of either an acute or subacute attack of caisson disease.

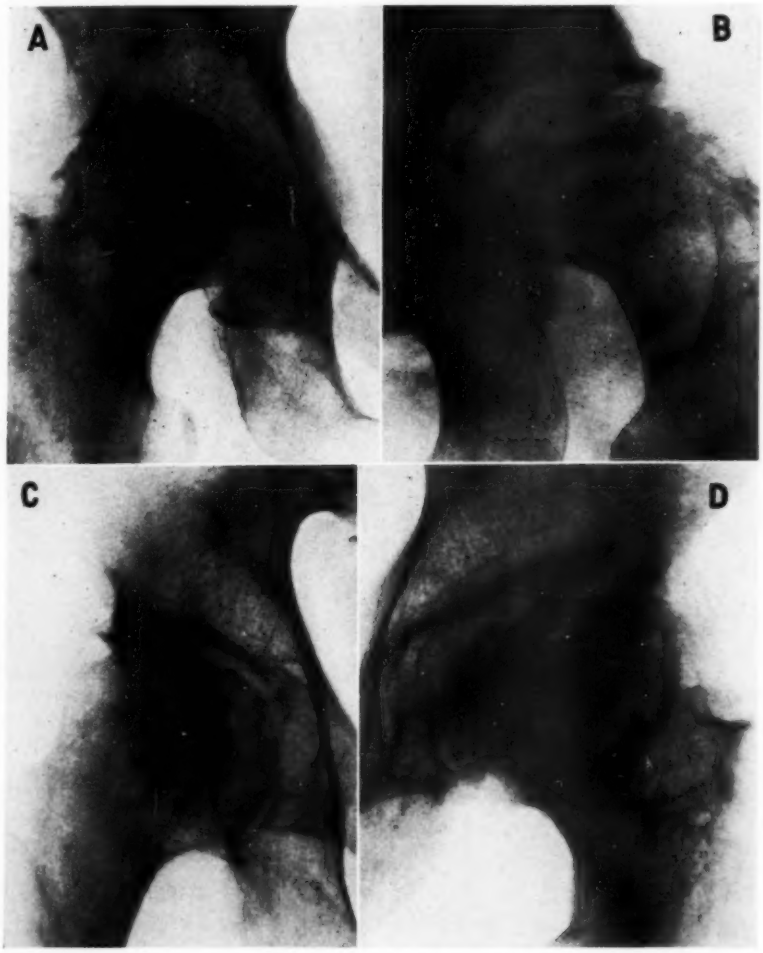

Fig. 10. A. J. G., white male, age 61, was a longshoreman, with a previous history of fracture of the head of the right femur. The head of the femur shows uneven density associated with aseptic necrosis. The joint space is narrowed. No history of exposure to compressed air.

B. G. B., white male, age 46, had poliomyelitis at the age of 2, with 10 cm. shortening of the right leg. He gave a 3-year history of pain in the left hip. No history of exposure to compressed air. Aseptic necrosis.

C. H. McF., white male, age 43, gave a long history of exposure to compressed air, admitting 7 or 8 attacks of the bends. The head of the right femur shows aseptic necrosis.

D. D. C., white male, gave a long history of exposure to compressed air, with several attacks of the bends. The head of the left femur shows aseptic necrosis.

It is of interest to note that bone and joint changes have been found in persons working under increased pressure with no history of accidents during their em- Such lesions—usually discovered accidentally and clinically without symptoms—are difficult of explanation. At the present time the implication is that they are re-

lated etiologically to the occupation. Actually, they are not occupational lesions. If the circulatory tree is adequate and decompression is properly conducted, bone or joint changes should not develop. If the circulatory tree is inadequate, bone and joint lesions may develop in spite of so-called adequate decompression, even in the absence of an acute attack of caisson disease. To quote End again, the agglutination of red cells may play a part. Such persons are exposing themselves to an occupation which may be considered hazardous for them even under ideal conditions and with so-called proper decompression. These lesions may not become manifest for many years—in some instances many years following the cessation of the dangerous occupation.

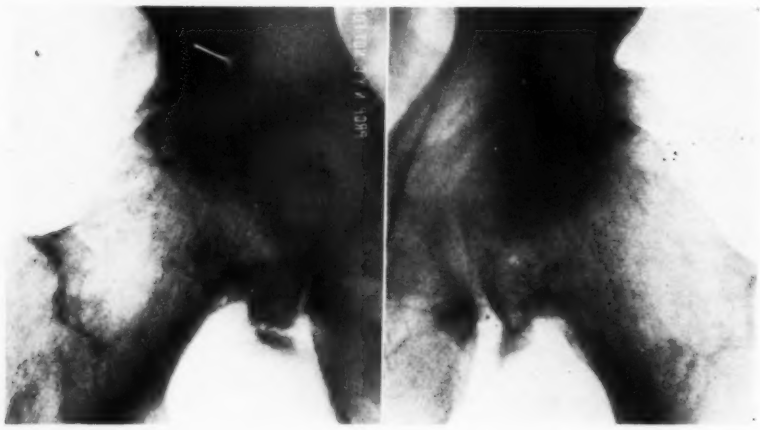

Fig. 11. J. Z., white male, age 58, was exposed to compressed air for 2 months during 1907. He denied any attacks of the bends. He discontinued his occupation 35 years ago because of pressure deafness. In 1924 he suffered a fracture of right foot. Pain in left hip developed 2 1/2 years ago, followed by pain in the right hip and knees, and the patient had to use a cane in order to walk. The femoral heads show areas of uneven density with sclerotic bone changes, narrowing of the joint spaces, and erosion of the articulating cartilages. There are productive bone changes.

The same factors which apply to workers under increased pressures apply to those exposed to decreased pressures. The rate of decompression from 4 atmospheres to 1 atmosphere holds the same relationship to the development of acute or subacute symptoms of aero-embolism as the rate of progress from 1 to 0.25 atmosphere in the case of aviators. In each instance, the ratio is 4 to 1. Nitrogen saturation for aviators occurs at ground level or 1 atmosphere, whereas in caisson workers and divers saturation occurs under increased pressure. In each instance supersaturation becomes manifest with a rapid decrease in pressure, resulting in the liberation of nitrogen into a gaseous state.

Korb recently described the occurrence of aero-embolism in three of a group of aviators in an instructional flight. The rate of ascent was comparatively slow and oxygen masks were worn for two hours preceding flight by all participants except the instructor, who wore his oxygen mask for ten hours prior to the flight. The aero-embolism in these fliers was attributed to physical activity attendant upon their duties, which required intermittent removal of their masks.

Behnke, in a recent article, indicated that some aviators will attain an altitude of 20,000 feet, and others 25,000 feet, ascending at the rate of one mile per minute, before developing acute symptoms of aero-embolism. This may possibly be accounted for by individual differences in circulation. Those with a more adequate circulatory tree (larger cross section), a better anastomosis of the blood vessels,

and a more rapid rate of blood flow per unit of time, may ascend to higher altitudes before symptoms of aero-embolism develop. Behnke also states that "the variation in susceptibility to compressed air illness makes necessary a specific decompression test for the selection of deep sea-divers." Similar tests are used for the selection of air pilots.

Bone and joint changes have not been observed in fliers who have suffered attacks of aero-embolism, and Behnke has not found such changes in the naval personnel engaged in deep-sea diving and the salvaging of disabled submarines. Escape without mechanical contrivances from a sunken submarine 100 feet below sea level (4 atmospheres) must be rapid for survival. This feat is accompanied by an acute attack of the bends, but bone and joint changes have not been observed. Nor have they been encountered following the rapid ascent of divers. This is of interest because, when acute symptoms are present, such persons are immediately placed in decompression chambers, which make possible the removal of the nitrogen from locations where it might interfere with the

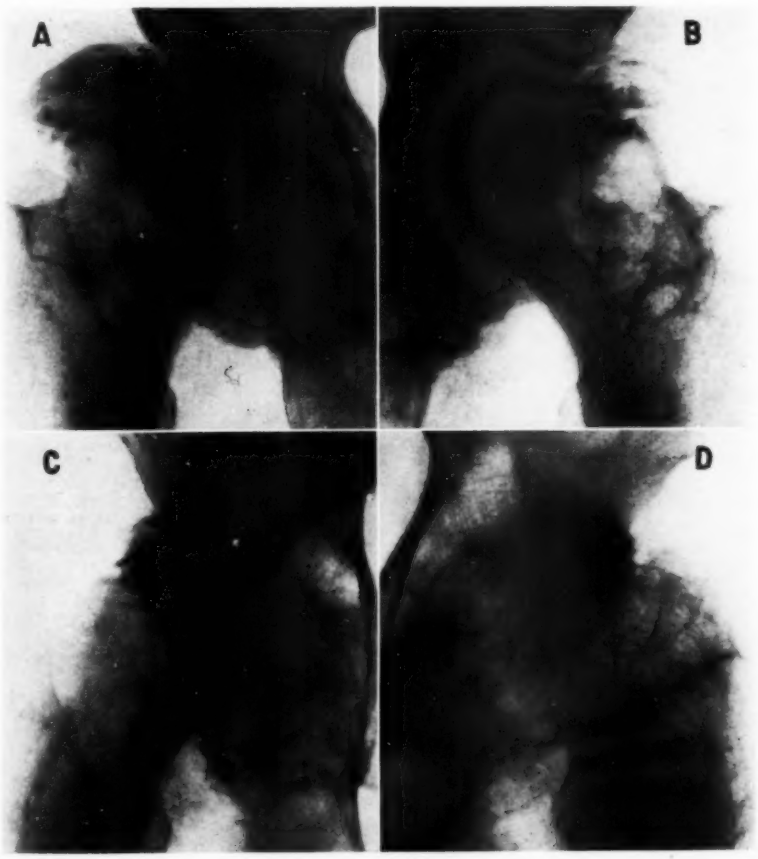

Fig. 12. A and B. J. McF., white male, age 71, had general arteriosclerosis and osteoarthritis, with progressive increase in pains for 8 or 9 years, necessitating use of cane. Occupation: Special officer. No history of exposure to compressed air. Extensive hypertrophic osteoarthritic changes.

C and D. P. T., white male, age 61, had osteoarthritis of hips and spine of 2 years' duration. He gave a history of gonococcal infection many years ago. No fractures. No history of exposure to compressed air.

blood supply to a given area. This is accomplished quickly and prevents tissue damage.

No explanation is available for bone and joint lesions identical with those described above, in persons who have never worked under compressed air or been subjected to rapid changes in atmospheric pressure. Mention has already been made of the cases of this type reported by Kahlstrom, Burton and Phemister and subsequently by Kahlstrom. My own series of 41 non-occupational cases, also mentioned above, constituted part of a larger group of 54 cases of bone infarction and aseptic necrosis. Of the 41 patients giving no significant occupational history, 13 were women, ranging in age from 30 to 80 years. The age range for the men was from 24 to 86.

SUMMARY

The subject of bone and joint lesions in workers in compressed air is discussed and the occurrence of similar lesions in persons with no such occupational history is noted.

The author's own observations include 54 patients showing aseptic necrosis and bone infarcts, of whom 13 were females. Of the 41 males, 12 gave a history of continued occupational exposure to compressed air, and one gave a history of a single exposure. The others gave no occupational history.

Of the 13 patients who had worked under compressed air for varying periods of time, some were subjected to sudden changes of atmospheric pressure and had experienced symptoms of aero-embolism, decompression illness, or bends. Others were not subjected to sudden changes in atmospheric pressure. Of this latter group some had mild or subacute symptoms of decompression illness and others did not.

Shaft and joint lesions do not develop immediately following decompression illness. Considerable time must elapse. The shaft lesions are usually asymptomatic and are discovered accidentally. In the joints, secondary arthritic changes occur, resembling a chronic hypertrophic osteoarthritis.

The lesions observed in the 41 patients who had never worked under compressed air and had never been subjected to sudden or violent changes in atmospheric pressure were similar to those in the occupational group. Some of the lesions presented identical roentgen appearances and could not be differentiated from the occupational cases. Aseptic necrosis was found in one case of sickle-cell anemia with a history of rheumatic fever and a polyarthritis.

In the caisson worker, the etiological factor is the presence of an inert gas, nitrogen, in bubble formation, either forming an embolus or producing pressure, or both, thus interfering with the circulation to the part. In the non-caisson worker, there is no apparent etiologic factor. The explanation of the circulatory obstruction remains unknown.

The bone lesions may be single, though usually they are multiple and often bilateral. Caisson workers presented extensive and multiple lesions more often than others. In the non-caisson worker, where the lesion is single and not extensive, the reparative changes are usually greater.

Deep-sea divers and aviators may develop aero-embolism. There are, however, no recorded evidences of bone changes in either naval or air personnel who have had attacks of aero-embolism.

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Right Aortic Arch with Report of Eight Cases[1]

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RIGHT AORTIC arch has long been known in the anatomical literature as a rare congenital defect of the aorta. Maude Abbott (1) lists 13 instances of this abnormality in her collection of 1,000 cases of congenital heart disease. Garland (2), in 1938, was able to collect from the literature the records of 113 cases. It is only since 1926, however, when the criteria for the roentgen diagnosis of this condition were laid down by Arkin (3) and by Renander (4), that it has become possible to diagnose this congenital defect during life. In 1939 Metzger and Ostrum (5) reported its recognition roentgenologically in 18 patients, to which series they added 2 cases of their own.

ANATOMY

There are two varieties of right aortic arch. In the simple or anterior type, the aortic arch loops over the *right* main bronchus and then passes straight downward, the transverse arch being anterior to the trachea and esophagus as in the normal subject. This type is uncommon; it is rarely encountered in the roentgen literature and will not be discussed in this paper. In the posterior or retro-esophageal type (Fig. 1), to which all of our cases belong, a more complicated course is followed. After passing over the right main bronchus, the transverse arch takes a turn to the left behind the esophagus, It then swings to the right and descends as a rule slightly to the right of the midline. From the ascending portion of the arch, before it passes over the right bronchus, the left subclavian branches off from a common trunk with the left common carotid and passes to the left, in front of the trachea. From the anterior surface of the descending arch, after it has emerged to the left from behind the esophagus, there arises a diverticulum which is joined to the left subclavian artery by a short obliterated vessel. With this arrangement the trachea and esophagus are surrounded by a complete vascular ring, the tightness of which presumably determines whether or not compressive symptoms will arise. This peculiar vascular arrangement in front of the trachea is regarded by Arkin as the formative structure of the left aortic arch, the obliterated vessel connecting the left subclavian artery with the left pulmonary branch representing an isthmus stenosis. He considers this type of right aortic arch as essentially a double

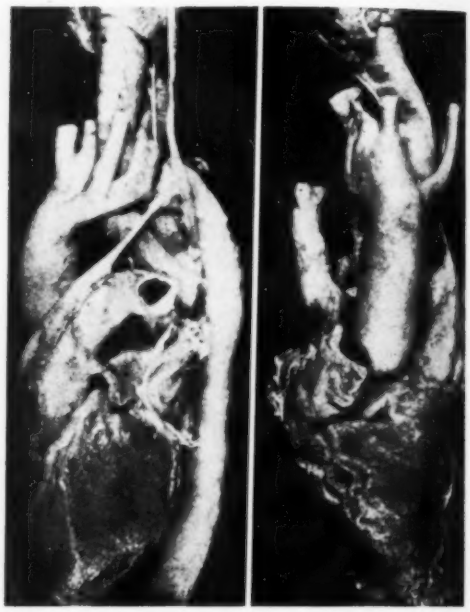

Fig. 1. Anterior and right lateral views of a right posterior aortic arch removed at autopsy. The transverse arch of the aorta is seen to be posterior to the trachea, as are also the right innominate, common carotid, and subclavian arteries. In front of the trachea are the abnormal left innominate and its branches, the left common carotid, and subclavian arteries. The subclavian artery can be seen attached to the aortic arch just to the left of the trachea. The aortic diverticulum, under postmortem conditions, does not appear prominent. (From Arkin.)

[1] Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1–2, 1943.

aorta, representing a throw-back to the reptilian type of heart.

EMBRYOLOGY

For a proper understanding of the bizarre anatomical picture, it is necessary to review briefly the development of the aortic arch (Fig. 2). In the 4–5-week embryo the blood leaves the primitive two-chambered heart by a single vessel, the truncus arteriosus, which soon divides into two branches, the ventral aortae. These are connected by six branchial vessels with the paired dorsal aortae. Of pertinent interest is the subsequent development of the fourth branchial arches. The right fourth arch forms the innominate and subclavian arteries. The left fourth arch, with the persisting portions of the ventral and dorsal aortae, forms the normal aortic arch.

In the course of these complex developmental changes various anomalies may occur. The nature of the anomaly, its location, and the developmental stage at which it supervenes will determine which of the various congenital abnormalities of the aortic arch will result. If a stenosis appears in the left fourth branchial vessel early in embryonic life, before the right fourth vessel has evolved into the subclavian artery, then the right fourth branchial arch will develop into the functioning aortic arch. According to this theory, supported by Arkin, the left subclavian artery and the diverticulum represent essentially an aborted left aortic arch and the obliterated vessel joining them indicates the area of stenosis.

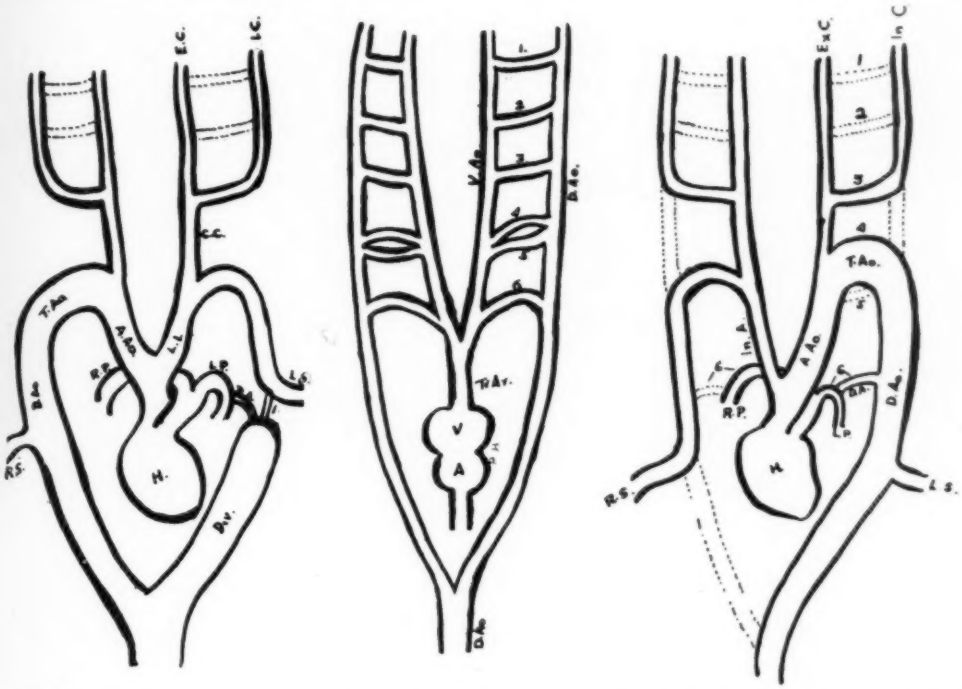

Fig. 2. The center drawing shows the scheme of circulation in a 4-week human embryo (or in the adult fish) At the right is shown the development of the normal left aortic arch; at the left the development of the abnormal right aortic arch.

A. Primitive auricle. A.Ao, T.Ao, D.Ao. Ascending, transverse, and descending arches of aorta. C.C. Common carotid artery. D.A. Ductus arteriosus. D.Ao. Dorsal aorta. I. Atresic vessel connecting left pulmonary branch with aortic diverticulum. In.A. Right innominate artery. L.I. Left innominate artery. L.P, R. P. Left and right pulmonary branches. L.S. R.S. Left and right subclavian arteries. Tr.Ar. Truncus arteriosus. V.Ao. Ventral aorta.

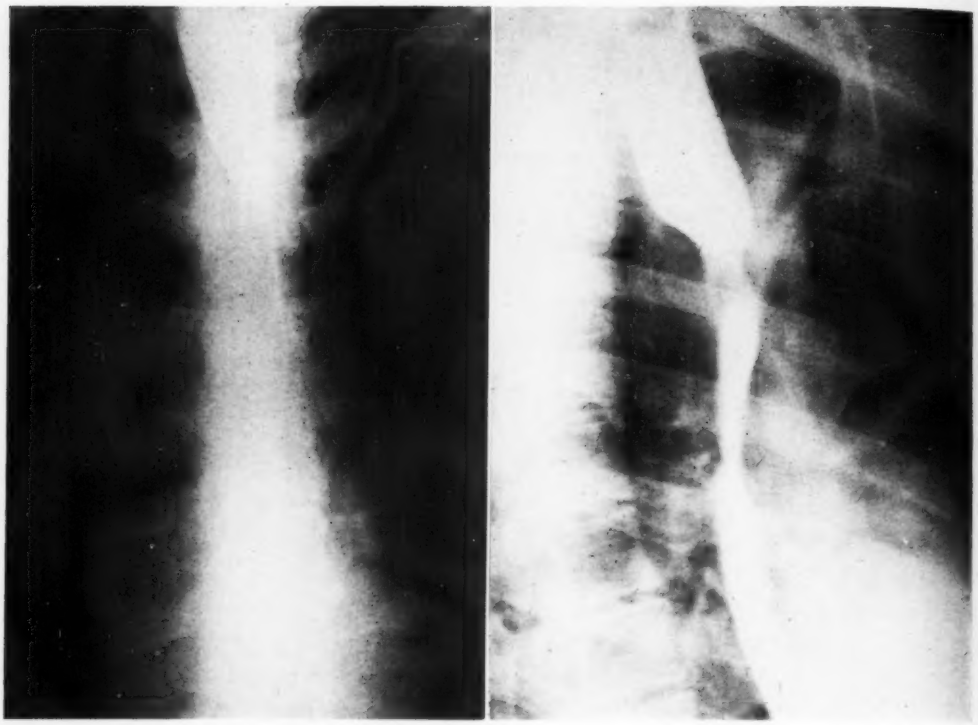

Fig. 3. Case I: Miss B. P., age 21, had no complaints with reference to swallowing but x-ray examination showed definite but symptomless obstruction at the level of the aortic crossing behind the esophagus. There is a smaller indentation on the anterior wall of the esophagus at the same level. This is probably due to remnants of the left (anterior) aortic arch.

CLINICAL FINDINGS

The term "dysphagia lusoria," which is frequently used as a synonym for right aortic arch gives a wrong impression, as in only a minority of the reported cases is there a history of dysphagia or other compressive phenomena. Such symptoms, however, even severe in nature, may occur (2, 5). There are no cardiac symptoms, and the heart is found to be normal on examination. Various clinical signs have been mentioned as characteristic of persistent right aortic arch (3), but a definite diagnosis can be established only on the basis of a careful roentgen examination.

ROENTGEN FINDINGS

The roentgen appearance is quite pathognomonic, more so than in any other congenital abnormality of the heart or great vessels. The findings may be divided into two groups—those due to the abnormal position of the aortic arch and those due to its absence from the normal position. In the former group is included the characteristic right-sided shadow of the ascending arch of the aorta. Pulsation, especially in its upper portion, may be difficult to detect. The dextrally placed ascending aorta rises about 1 or 2 cm. higher than normally, to about the level of the sternoclavicular articulation, before merging with the transverse arch. This increased height of the transverse arch is due to the fact that it crosses over the *right* main bronchus, which is on a higher level than the left, and forms an important diagnostic feature in this condition.

In the right anterior oblique position the transverse arch of the aorta may be seen tangentially or in contour as a rounded

Fig. 4. Case II: Mr. M. L., age 33. The ascending arch of the aorta is well shown. The esophagus shows typical displacement to the left and forward. No left arch remnants are seen here, hence no obstruction.

or slightly oblong shadow. Within this shadow there has been described a smaller, darker, rounded shadow supposedly due to the superimposed shadow of the diverticulum. Such a shadow would presumably occur only if the angle of obliquity was such that these structures were exactly superimposed. I have not recognized it on any of my films. The aortic shadow is situated immediately anterior to the spine instead of in the normal position, where it is separated from the spine by the radiolucent trachea. The part of the trachea which is immediately in front of the transverse arch shows a definite forward bowing and occasionally a slight stenosis. More obvious, and hence more diagnostic, is the displacement of the esophagus seen when barium is administered. This structure is displaced to the left by the ascending and forward by the transverse arch, and its right and posterior surfaces are indented by these respective portions of the arch. The indentations are proportional to the size and shape of the portions of the aorta involved. The width between the esophagus and the right border of the vascular shadow in the anterior view represents the width of the ascending aorta. A small indentation is sometimes seen on the left and anterior walls of the esophagus at the same level as the larger one on the right and posterior walls (Case I). I believe that it is due to pressure from the left aortic arch remnant, either the subclavian artery as it passes in front of the esophagus or the diverticulum on its left side. The presence of this indentation would imply a tightness of the vascular ring around the esophagus and trachea, and one would expect to find objective evidences of obstruction in these cases, as was indeed true in Case I.

In films taken with the Bucky diaphragm in the dorsal or ventral position the tho-

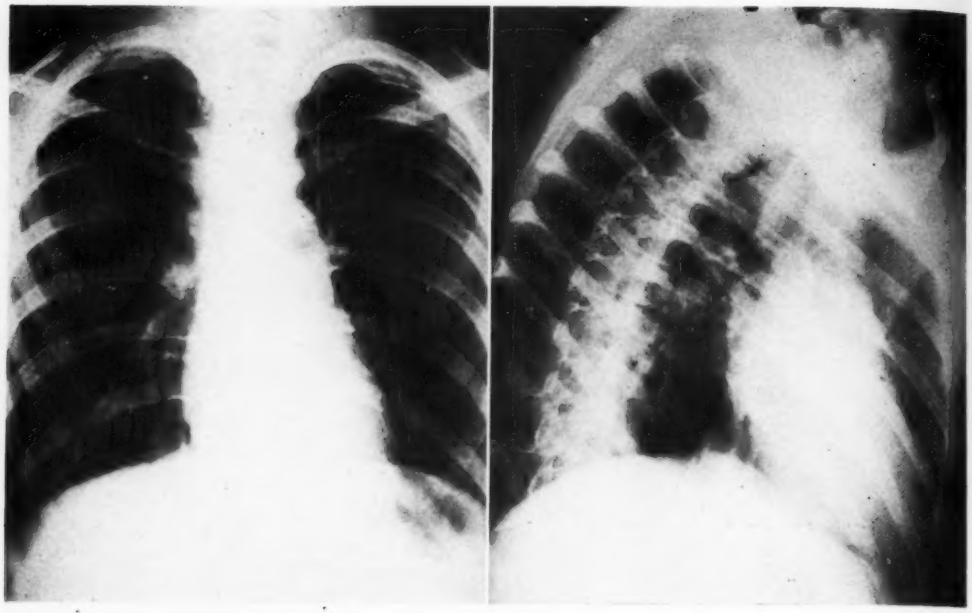

Fig. 5. Case III: F. C., 11-year-old girl. The condition was discovered during examination of the colon. Since the patient could not co-operate very well, proper films with barium in the esophagus could not be taken. Fluoroscopic examination, however, showed typical displacement and indentation of the esophagus. Films showed absence of the left aortic knob and typical anterior displacement of the trachea in front of a rounded shadow which is the transverse arch of the aorta seen in transection.

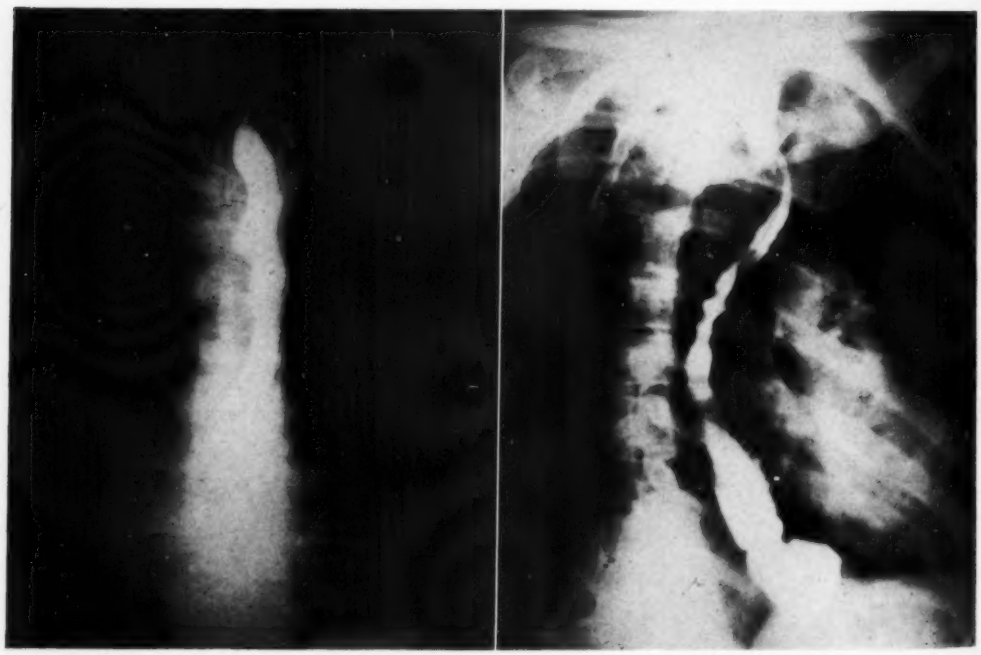

Fig. 6. Case IV: Mr. M. S., age 48, had coronary heart disease. The esophagus shows typical displacement but no obstruction. The patient's children were examined and found free from abnormality. This was the only patient who was referred for heart examination.

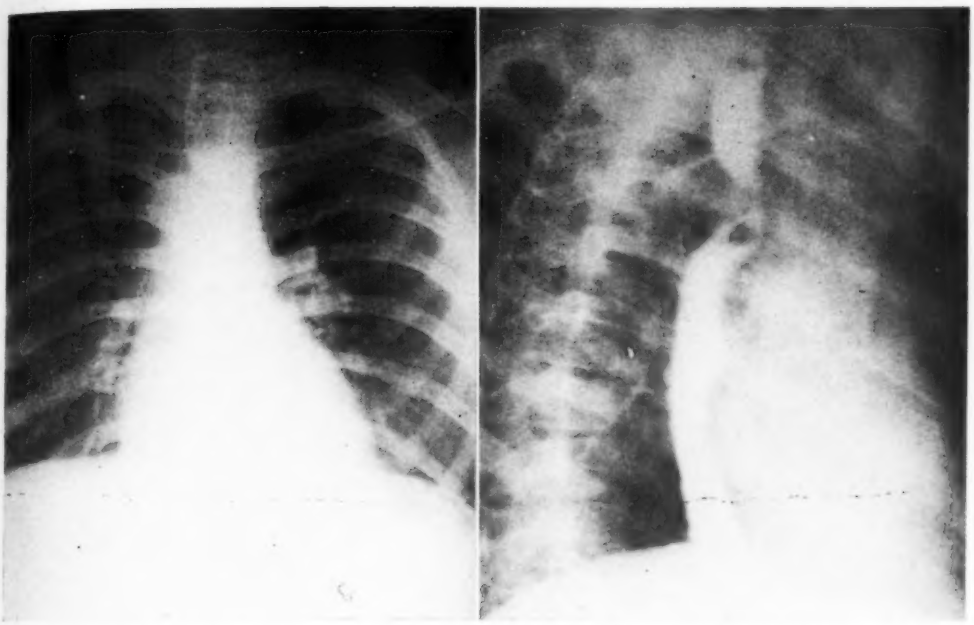

Fig. 7. Case V: F. G., 13-year-old boy. The films show well marked indentation of the right and posterior walls of the esophagus and a slight objective dysphagia.

racic aorta can usually be seen through the right border of the heart, just to the right of the spine. This appears most spectacularly when the aorta is lengthened by sclerosis and dilatation and might be mistaken for an aneurysm of the ascending aorta.

In the absence of the aorta from its normal position, the aortic knob, which normally forms the uppermost arc on the left border of the cardiac silhouette, will not be seen. This gives a striking appearance and may serve to draw attention to this condition. A small knob may, however, be present due to an unusually prominent diverticulum or, more likely, an enlarged left subclavian artery crossing in front and to the left of the esophagus. The heart is commonly displaced slightly to the right, and its upper border is usually more clearly visualized than normally. On this area the descending portion of the arch is ordinarily superimposed. When the latter is to the right, and especially when the thoracic aorta is also on the right side, this area has no obscuring shadows and hence appears clearer.

DIFFERENTIAL DIAGNOSIS

The presence of any one of the criteria outlined above may not be sufficient to establish a diagnosis of right aortic arch. A right-sided mediastinal shadow may be due to a mass of lymph nodes or neoplasm or a dextrally displaced superior vena cava or innominate vein. The absence of pulsation does not definitely exclude these, as pulsation is sometimes difficult to detect in right-sided arch. A dilated or dextrally displaced ascending arch of the aorta may offer some difficulty, especially if encountered on a flat film without fluoroscopy. In this case the height of the aortic arch is the important diagnostic feature. If the arch is at a normal level, the condition is not a right aortic arch. Displacement of the esophagus and trachea may be due to mediastinal tumor. Absence or hypoplasia of the normal left aortic knob may be associated with other congenital diseases of the heart, notably interatrial septal defect, patent ductus arteriosus, and coarctation of the aorta. In the reported cases the condition was most frequently

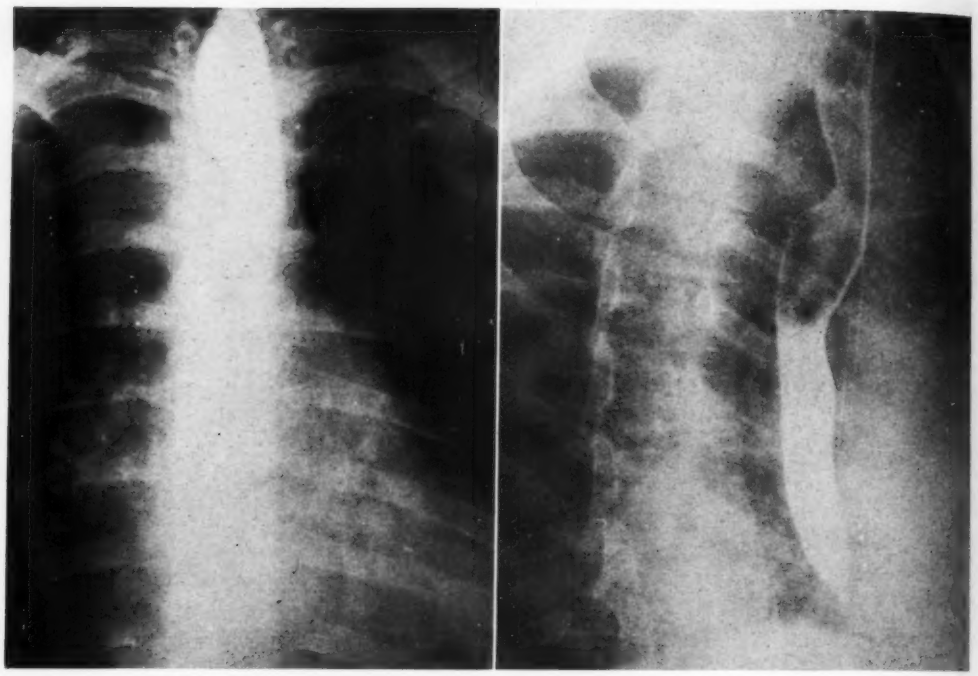

Fig. 8. Case VI: Mrs. K. D., age 26. Typical displacement and indentation of the esophagus; no indentation from left arch remnants; no obstruction.

mistaken for aneurysm of the ascending aorta and mediastinal tumor.

CASE REPORTS

Our 8 cases of right aortic arch were seen in the three years between Jan. 1, 1941, and Jan. 24, 1944. During this period 1,895 chest examinations were made by films only and in another 2,305 patients by fluoroscopy, the latter being for the most part a routine screening during the course of a gastro-intestinal examination. All of our cases were found in the group studied fluoroscopically, an incidence of about 0.35 per cent or about 1 in 288 cases. No case of right aortic arch was recognized in the group undergoing flat film examination only. In several of this group where the appearance seemed suspicious, subsequent fluoroscopic examination showed the aorta to be normal. This would imply that fluoroscopy is essential to the diagnosis of this condition. It is undoubtedly frequently missed on flat film readings.

The question of hereditary predisposition was not gone into carefully. In Case IV the patient's two children were examined and in Case III the patient's mother was observed fluoroscopically. In none of the relatives was any abnormality of the heart or aorta found, nor did any of the patients show other congenital abnormalities, with one exception (Case VII), a man of 46, who exhibited a fusion of the 5th and 6th dorsal vertebrae and thirteen well formed thoracic ribs on the left side.

There is no evidence of any sex predisposition. Five of the patients were males and 3 females. The ages varied from eleven to forty-eight; 4 patients were under thirty and 4 between thirty-one and fifty.

In none of the series were there any symptoms referable to the abnormality. In Case I there was a moderate but symptomless esophageal obstruction. Five of the cases were recognized during fluoros-

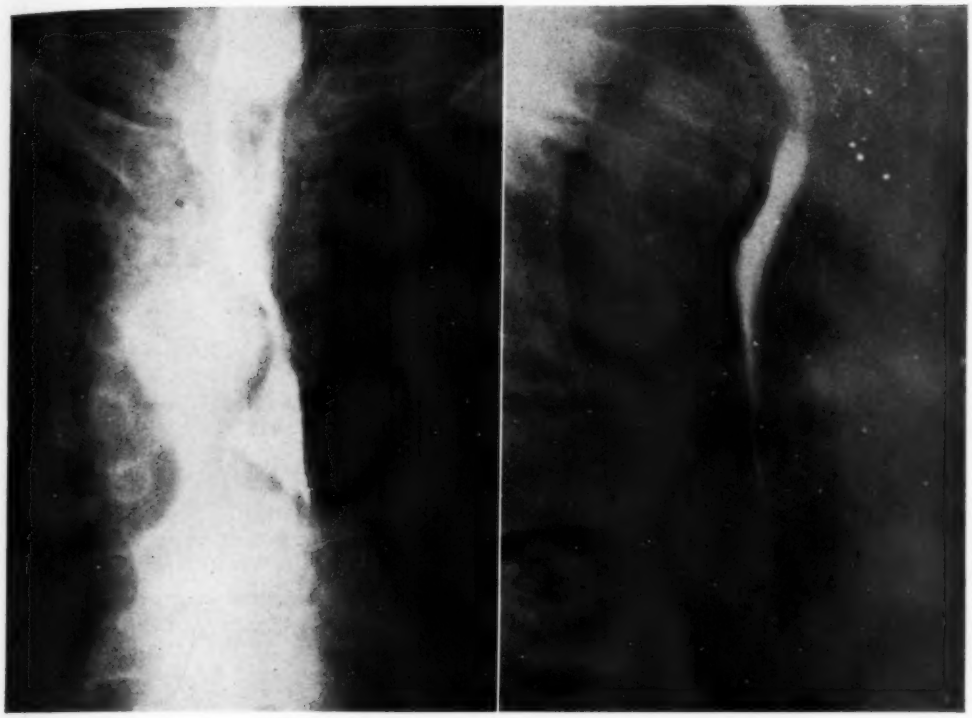

Fig. 9. Case VII: Mr. J. T., age 46, showed other congenital abnormalities, namely, a fusion of the 5th and 6th dorsal vertebrae and 13 well formed thoracic ribs on the left side.

copy of the chest preliminary to a gastrointestinal examination, one during a barium enema study, and 2 during fluoroscopy of the chest for clinical conditions not referable to this abnormality. In no case was any abnormality of the heart detected on clinical examination. In 4 of the patients electrocardiograms were made, and all were found negative.

The roentgen findings were as detailed above. They were so essentially similar that it is not considered necessary to record them separately in each case.

SUMMARY

Right posterior aortic arch is a congenital abnormality due to a defect of the formative structures of the left aortic arch occurring early in embryonic life and leading to the development of the right fourth branchial artery as the functioning aortic arch. The heart is uninvolved in this abnormality. The condition may be associated with compression of the trachea and esophagus, but is usually symptomless. It is probably not as rare as the paucity of reported cases would indicate. The incidence in our series was about 1 in every 288 patients subjected to fluoroscopic examination of the chest.

Fluoroscopy, preferably with barium in the esophagus, is essential to the diagnosis of this condition. It may easily be missed on flat film examination. This may account for its alleged rarity. The pathognomonic findings are the right-sided shadow of the ascending arch of the aorta, compressing the esophagus and displacing it to the left and the high transverse arch crossing over the right bronchus, associated with a forward bulging of the trachea and esophagus over the posteriorly situated transverse arch of the aorta. Other findings are absence of the normal aortic

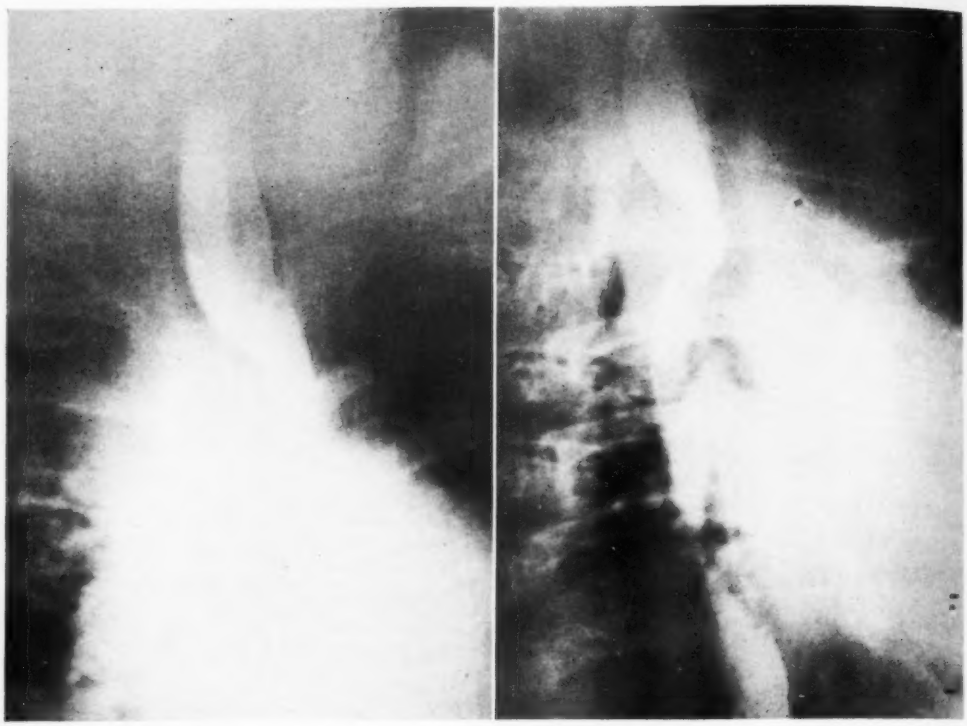

Fig. 10. Case VIII: Mr. E. J. P., age 46. There were no symptoms referable to the abnormality, which was discovered during routine chest fluoroscopy.

knob and an unusually clean-cut appearance of the pulmonic conus region of the heart, due to the fact that the descending portion of the aortic arch is not superimposed on this area.

This abnormality is of interest to the radiologist not only because of the compressive symptoms with which it is occasionally associated but because of the importance of distinguishing it from other more serious diseases.

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Accidental Trauma and Tumor Metastasis[1]

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AMONG THE NUMEROUS reports on the subject of trauma and cancer, few deal with the relationship of accidental injury and metastatic deposits, and such opinions as are expressed are confusing and contradictory. Any clinical or experimental observation contributing to the clarification of this unsettled problem is therefore worthy of presentation. The matter is especially important from the medicolegal standpoint. Many cases involving this question reach the higher courts, partly because of contradictory medical testimonies and partly because of the large sums of money involved.

Two cases are presented with contributory clinical and experimental data.

CASE REPORTS

CASE 1: F. D., white male, age 55, was admitted to the St. Francis Hospital (Olean, N. Y.) on March 23, 1942, because of injuries. On the day of admission, while the patient was helping unload parts from a box car, the bed section of a scavenger hooked onto the crane tipped over and fell against him, damaging his right arm especially. He suffered severe injuries of the right wrist and forearm, with lacerations along the radial and flexor surfaces, as well as brush burns of the right thigh and leg, with a fairly deep laceration at the lower lateral aspect of the right thigh, a few inches above the knee joint. A slightly painful sprain of the left thumb was also present. Four sutures were inserted to close the largest laceration of the right forearm.

On the day of admission, the patient's temperature was 98° F., pulse 80, respiration 20. The physical examination revealed nothing of significance except for the injuries mentioned above. The blood count showed 4,000,000 red cells, 84 per cent hemoglobin, and 7,400 white cells with 80 per cent polymorphonuclears. The urinary findings were essentially normal. Roentgenograms of the right wrist region, made on the following day, showed a slightly comminuted oblique fracture of the radius about an inch above the articular surface, probably not involving the latter. There was moderate angulation of the major fragments dorsally; otherwise they were in good position and alignment. Save for a small, apparently old ununited chip fracture of the radial styloid process, there was no evidence of a bone lesion. Small pockets and streaks of gas were noticed in the subcutaneous tissues of the radial aspect of the forearm. The soft tissues were moderately and diffusely swollen, as usually occurs with this type of trauma (Fig. 1). Under intravenous anesthesia with pentothal sodium (given into the left cubital vein), reduction of the right radial fracture was attempted by traction and angulation of the distal fragment. A cast was applied, extending to the arm, with the elbow at 90° flexion.

On the same day a soft pedunculated tumor, about 2 cm. in diameter, was removed from the flexor surface of the left forearm by knife dissection. The patient stated that this small lump had been present for many years. Histologically it proved to be a neurofibroma. The next day, March 25, 1942, the patient was discharged from the hospital.

About three weeks following discharge, the cast was changed and a half cast was applied for an additional week, after which a sling was worn for the support of the right arm. From this time on, *i.e.*, about four weeks after the injury, the patient began to experience some pain in his right wrist. A roentgenographic examination by the attending physician on June 8, 1942, showed the radial fragments in good position and alignment. Only moderate callus formation was demonstrable There was no evidence of bone destruction. The soft-tissue swelling appeared to be moderately decreased. On careful observation, however, it seemed to show some increase along the radial aspect.

Gradually the pain became more severe, and on June 30, 1942, the patient was referred to the hospital for a roentgenographic study. This examination showed the radial fragments in essentially the same position as before. Rather marked callus formation was noticed around the fragments, with the fracture lines, however, still visible. The bones of the wrist region, especially the carpus, showed a pronounced osteoporosis. A moderate soft-tissue swelling was present, especially along the radial aspect (Fig. 2). On the roentgenograms the measurements of the right wrist at the region of the fracture were as follows:

	P. A.	Lat.
March 24, 1942	6.7 ×	5.5 cm.
June 8, 1942	6.8 ×	5.0 cm.
June 30, 1942	7.2 ×	5.5 cm.

In the absence of definite bone destruction, it was thought that the early removal of the cast—three weeks after the injury—was possibly respon-

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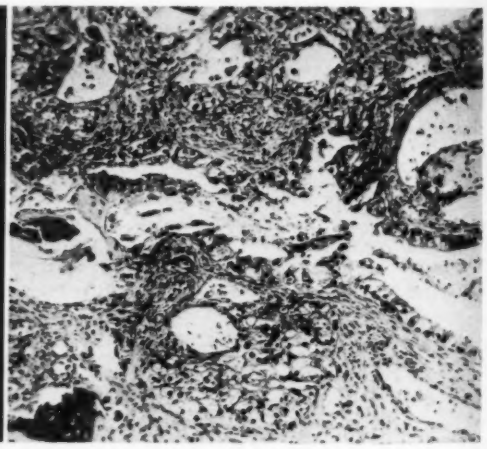
Fig. 1. Case 1. Fracture of right radius, with slight diffuse soft-tissue swelling and subcutaneous and interstitial emphysema. March 24, 1942.

Fig. 2. Case 1. Right wrist region: periosteal reaction; diffuse moderate soft tissue swelling; no evidence of bone destruction. June 30, 1942.



Figs. 3 and 4. Case 1. Tumor in the right wrist region. The roentgenogram, July 25, 1942, shows marked periosteal reaction. The fracture line is faintly visible. A large, round, sharply circumscribed soft-tissue tumor is present at the fracture site, with small flakes of calcification diffusely scattered in the mass. There is no definite bone destruction. Diffuse osteoporosis is apparently due to disuse. Pathological diagnosis: metastatic adenocarcinoma. Note the islands of bone in the photomicrograph.

sible for the pain, swelling, and exuberant callus formation. Immobilization and further observation were recommended. The forearm was again put in a cast, and the patient felt better for about a week, with only slight pain in the wrist. At this time, his physician decided to apply a somewhat tighter cast. According to the patient, the slight manipulation of the arm produced severe aggravation of the pain, which in a few days became almost intolerable. The swelling also increased, and the arm was put back in a sling.

On July 21 another x-ray examination was made, the wrist being studied in the postero-anterior, lateral, oblique, and tangential projections. This

examination revealed a large (about 2 inches in diameter), round, quite sharply circumscribed soft-tissue mass about the radial fracture, located mainly along the outer aspect of the bone. The radial fragments showed exuberant periosteal proliferation with a fairly typical reactive triangle along the outer surface of the proximal fragment. Flakes of calcification were diffusely scattered in the soft-tissue mass. Comparison with the roentgenograms of June 30, however, revealed no evidence of bone destruction. The radial fragments were in good position and alignment, with the fracture lines still faintly visible. A marked osteoporosis of the wrist region was present (Fig. 3).

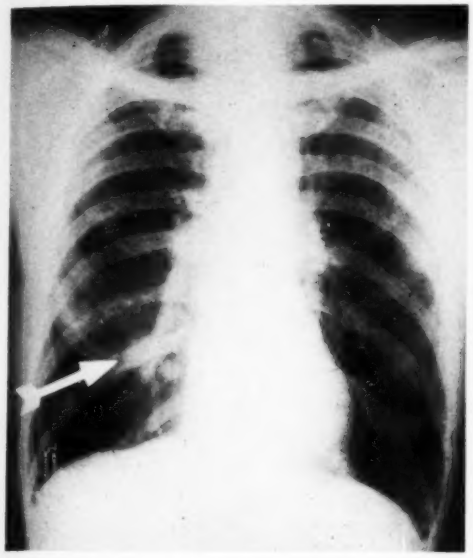


Fig. 5. Case 1. Roentgenogram of chest, showing multiple nodular lesions in right middle and lower lung fields. One of these nodules (arrow) was the primary growth. The left lung field is entirely clear. Aug. 6, 1942.

Some type of malignant growth was suspected, fibrosarcoma being mentioned among the possibilities. The clinical findings, however, favored an inflammatory lesion—a hot, red, tender mass; 12,450 white blood cells; occasional rise of temperature to 99 or 99.2°; 22 mm. sedimentation rate per hour (Wintrobe), and a history of open wounds in the vicinity. From the roentgenologic point of view, the rapid growth of the mass (in three or four weeks) required a rather active inflammation; its nearly spherical shape and sharp outline, however, pointed toward an inert swelling, such as is seen in chronic avirulent infection. In other words, the findings were contradictory as to the possibility of an infection. Save for the periostitis and the diffuse osteoporosis, no bony changes were demonstrable. No suggestion was made as to the possibility of a metastasis.

Fig. 6. Case 1. Right wrist region, about five weeks after surgical removal of soft-tissue tumor, showing diffuse soft-tissue swelling and evidence of definite bone destruction. The fracture line is hardly visible. A marked elevation of the periosteum with typical reactive triangle is present. Sept. 1, 1942.

On exploratory operation (July 26), a non-infiltrating, sharply circumscribed mass, only loosely attached to the bone, was enucleated. The surgeon had the impression that a slight amount of pus could be squeezed out of the mass. The tumor was fairly friable and showed a fleshy, somewhat granular, grayish-white cut surface. The culture taken from the mass revealed a growth of *Staphylococcus albus hemolyticus*. Histologic examination showed metastatic adenocarcinoma (Fig. 4).

A few days later, on August 6, a roentgenographic examination of the chest showed multiple round, sharply circumscribed lesions in the right lung field, apparently due to metastases (Fig. 5). There was a history of occasional slight cough in the last six months. The patient, however, denied the occurrence of any chest pain or bloody sputum.

A small subcutaneous tumor was also present in the right upper forearm, along the radial side, about 2 inches distal to the elbow joint. This was removed on July 28. This tumor (about 2 cm. in diameter) was some distance from the healed laceration of the forearm, embedded in the subcutaneous

tissues, not connected with the bone at all. Histologically it proved to be the same kind of adenocarcinoma as the one at the site of the radial fracture.

A thorough search was now begun for the primary tumor. Complete roentgen studies of the gastro-intestinal and genito-urinary tracts failed to locate it. No definite enlargement of the thyroid was noticed. The right testicle was somewhat larger than the left, but the patient claimed that he had had an enlarged right testicle for many years and he thought that it had not grown noticeably in the last few years. There was a history of mumps thirty-five years earlier. A subsequent Friedman test was negative.

opiates, the right forearm was amputated on Sept. 17. The pathological specimen showed the bulk of the tumor to be located outside of the bone, which was evidently involved secondarily through infiltration.

During the next few months (October–December 1942) the patient lost about 15 lb. and became pale and weak. He complained of severe pain in the amputated right forearm and the right knee. The physical and roentgen examination of the latter showed only a slight diffuse soft-tissue swelling along the lateral femoral condyle, but no pathological changes in the bones (Fig. 7).

In the latter half of December 1942, in addition to

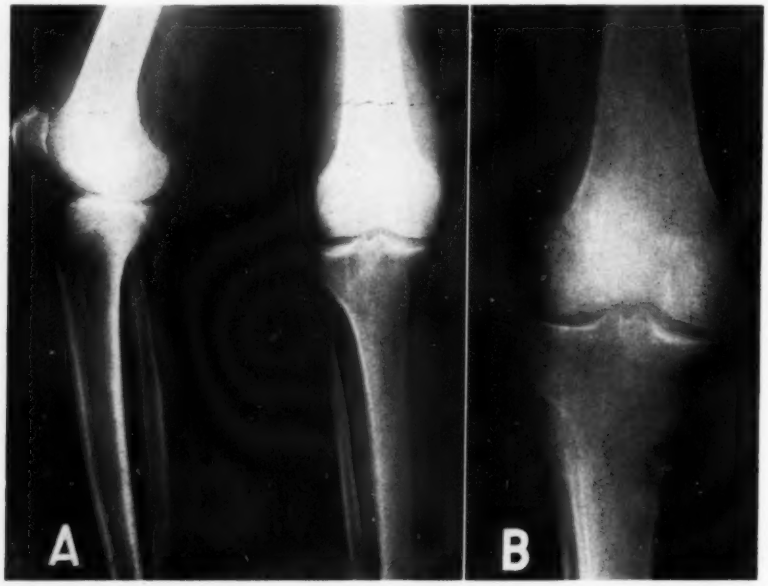


Fig. 7. Case 1. Right knee region. A. Roentgenogram, Nov. 8, 1942, showing moderate diffuse soft-tissue swelling above the patella, mainly anteriorly and laterally. A very slight periostitis is present at the lateral aspect of the distal femur. B. Post-mortem roentgenogram, April 6, 1943, showing marked soft-tissue swelling at lateral aspect of distal femur, evidence of periostitis, and suggestive signs of bone invasion by the overlying mass.

At the end of August, the patient was referred to the State Institute for the Study of Malignant Diseases in Buffalo. A roentgen examination of the right forearm, including the wrist region, made on Sept. 1, 1942, showed definite evidence of bone destruction (Fig. 6). The previous large soft-tissue tumor and now the disappearance of the cortex on one side and the asymmetrical erosion of the marrow cavity were strongly suggestive of destruction from an external rather than an internal cause. No definite conclusion was reached about the location of the primary tumor. The patient was sent back to his local physician for palliative treatment.

Because of the intolerable pain, which could not be relieved by x-ray treatments (1600 r/skin) or the increasing diffuse swelling of the right knee, a small tumor developed on the anterior aspect of the left leg, the result, according to the patient, of a slight bump suffered at the site three or four weeks previously. Roentgen examination revealed a beginning infiltrative destruction of the tibia by the overlying growth (Fig. 8).

Early in 1943 small subcutaneous nodules appeared in the abdominal wall and back, as well as in the right arm, left thigh, and left angle of the jaw. The left upper forearm also showed a painful, probably intramuscular, fusiform mass. Radiographically no other bone lesion except a moderate periosteal reaction of the radius and ulna was demonstrable in the region of the tumor (Fig. 9).

There was no evidence of lymph node enlargement in any part of the body. The patient eventually became bedridden.

Because of the extreme difficulty of reaching a definite conclusion on the relationship of the patient's injury to the metastatic growth at the fracture site, a slight artificial injury was inflicted on the anterior part of the right leg, corresponding with the location of the metastasis in the left leg. It was felt that an ideal condition was present here for a post-traumatic metastasis—if any relation at all existed between the injury and the tumor—for the following reasons. (1) An apparent generalized spread of the primary growth was present. (2) The type of trauma which supposedly caused the appearance of the growth in the left leg could be exactly duplicated. (3) Essentially the same anatomical location could be selected. (4) An apparent metastasis was developing at the right knee, only a short distance from the selected spot for the experimental trauma.

The pretibial skin and the scanty subcutaneous tissues of the middle third of the leg were infiltrated with about 8 to 10 c.c. of 2 per cent novocain. Following this, repeated blows were delivered with the wooden handle of a hammer. A hematoma was produced, with signs of moderate swelling and a slight reddish discoloration of the skin. Photographs and roentgenograms of the leg were taken before and after the procedure.

The patient died on April 6, 1943, more than two months after the slight experimental bruise, but repeated physical and roentgenographic studies, as well as postmortem examination, failed to reveal any tumor at the site of the trauma which had been inflicted (Fig. 8).

On postmortem examination, the primary lesion was found, after some difficulty, to be one of the larger nodules in the right lung, close to the hilum. Its exact location was in the apical portion of the lower lobe, about 2 cm. from the hilum. A small branch of the lower lobe bronchus, as well as a large branch of the pulmonary vein, could be traced into this tumor. A large metastasis was present in the soft tissues of the right upper knee region, infiltrating the lateral femoral condyle. The adrenals were practically entirely replaced by large tumors. Metastases were also present in the right lung, some of the right hilar lymph nodes, thyroid, kidneys, and subcutaneous tissues and muscles of the trunk and extremities. An x-ray examination of the entire skeleton, shortly before the patient's death, failed to reveal any bone metastasis, with the exception of the right knee, left leg, and left forearm, where the bones were involved by overlying tumors in the soft tissues. The left lung, the stump of the amputated right arm (Fig. 10), areas of repeated intravenous and subcutaneous injections, showed no metastases. The right testis was normal in size; the left one showed atrophic changes. The gastro-intestinal tract showed no abnormality.

Fig. 8. Case 1. Left leg. A. Roentgenogram (Nov. 8, 1942) showing moderate soft-tissue swelling at anterior aspect of middle third and beginning erosion of underlying bone. This lesion was also claimed to be post-traumatic. B. Postmortem roentgenograms of both legs. Note large soft-tissue tumor in left leg, with infiltration of bone. The right leg, about two months after artificial traumatization of subcutaneous structures of the middle third, is negative for secondary tumor formation.

Fig. 9. Case 1. Left forearm, showing a diffuse, probably intramuscular, soft-tissue mass, definitely not connected with the injury. There is evidence of periostitis with displaced periosteal fragments in the adjacent mass. The appearance closely imitates the growth in the right wrist. Feb. 15, 1943.

Fig. 10. Case 1. Right arm, about two months after amputation of the forearm. There is no evidence of metastasis in either the soft-tissue structures or bone. The scar is completely healed. No tumor was demonstrable here on postmortem examination four months later.

Comment: In addition to the medicolegal importance of this case, interesting roentgenographic features were present. First of all, the unusual appearance of the metastatic growth in the right wrist region presented an extremely difficult problem in differential diagnosis. This secondary tumor evidently became localized first in the subcutaneous tissues and gradually invaded the bone. The presence of the fracture and the periosteal reaction were additional complicating features in the picture. The flakes of calcification, diffusely scattered in the mass, were evidently the result of displaced periosteal fragments. Without the presence of other metastases, the exclusion of a primary tumor, for instance fibrosarcoma secondarily involving the bone from without, could hardly have been possible. Radiographically, the rapid growth of the tumor, together with its spherical shape and sharp outline, was somewhat against an inflammatory mass.

The extreme rarity of the apparently hematogeneous, subcutaneous, and intramuscular metastases is another interesting feature of this case. Krasting reported only 2 cases of subcutaneous metastasis in 12,730 malignant tumors with generalized spread. Willis, in his book "The Spread of Tumours in the Human Body," mentions only 19 cases of discrete muscular metastases, including 4 of his own cases. In almost all these cases the primary neoplasms were of rapidly growing anaplastic character and had produced numerous metastases in other tissues.

The great difficulty in locating the primary growth also increased the interest in this case. The possibility of the primary lesion being in the thyroid was ruled out through the gross and microscopic anatomical findings. The huge bilateral adrenal masses were also suggestive of a primary lung cancer. The complete absence of metastases in the left lung was again somewhat against the probability of the thyroid being the seat of the primary lesion. The roentgenographic differentiation of the nodular primary growth from the other pulmonary metastatic deposits is hardly possible. Perhaps exclusion of other organs and the suggestive bronchial connection with one of the nodules should arouse the suspicion of this being the primary growth. The presence of several large nodules in one lung and the complete absence in the other should also help in the diagnosis. The slight irregularity in the outline of the primary nodule, mentioned by Kirklin as a differential diagnostic point, was not present in this case.

CASE 2: F. S., a 64-year-old white male, was admitted to the New Rochelle Hospital on July 10, 1939, having fallen off a roof, while at work, striking his head on a platform.

When the patient was seen at the hospital, he was suffering from slight shock and complaining of severe pain over the upper lumbar spine. He had an abrasion of the head over the left frontal region. He had been well up to the time of this accident and gave no history of abdominal complaints. On admission, the preliminary diagnosis was: possible skull fracture, abrasion of the scalp, possible fracture of the spine.

Roentgen examination of the lumbar spine, on the day of admission, showed a compression fracture of the first lumbar vertebra (Fig. 11A). The only positive finding on physical examination, outside of the injuries, was a small palpable mass in the epigastrium. Temperature, pulse, and respiration were normal. Urinalysis and the blood count were also without significance. In the first month in the hospital, the course was essentially uneventful, except for continuous pain in lower back and over left lower ribs. Because of the mass in the epigastrium and beginning abdominal pain, together with symptoms of indigestion, a stool examination was made for occult blood on July 22. This proved strongly positive.

On Aug. 29, a roentgen examination of the thoracic cage and lumbar spine revealed a destructive lesion

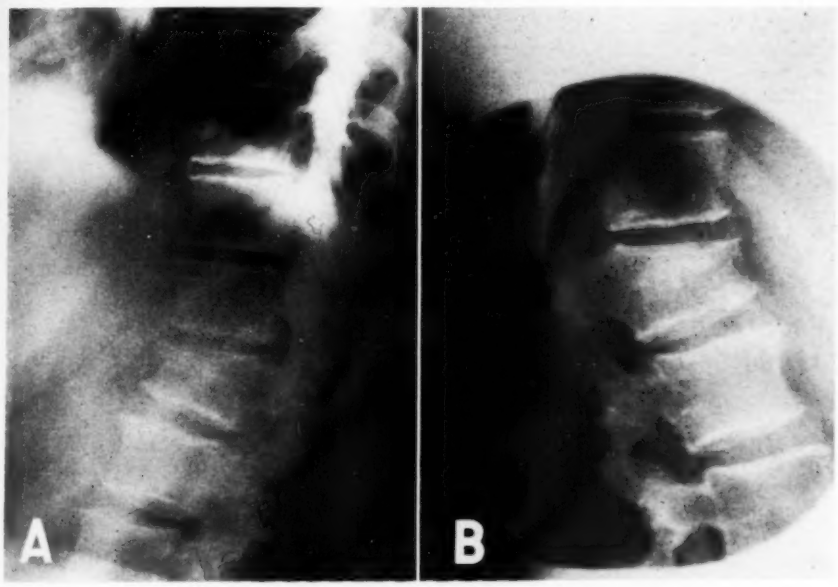


Fig. 11. Case 2. Roentgenograms of lower dorsal and upper lumbar spine: A. July 10, 1939; B. Aug. 29, 1939. Note absence of noticeable change in the fractured first lumbar vertebra on second roentgenogram (B) about six weeks after the injury. On postmortem examination, three months following the injury, no tumor cells could be found in the collapsed vertebra.

of the left 11th rib, suggestive of metastasis. The first lumbar vertebra appeared essentially the same as on previous examination, July 10, 1939 (Fig. 11B). The gastro-intestinal tract was not examined roentgenographically.

Examination on Sept. 14 showed the abrasion on the head to be completely healed. The mouth and pharynx revealed no significant changes. The thyroid was not enlarged. Several nodular tumors were present on the thoracic wall: one at the right side of the manubrium sterni, another over the xyphoid process, and one in the left mid-axillary line at about the level of the sternal xyphoid. All these nodules were hard and immovable, being probably connected with or having arisen in the underlying bony structures. The heart and lungs were essentially normal. A hard, tender mass, the size of an orange, was felt in the epigastrium. On percussion some tenderness was present over the mid-thoracic vertebrae. The blood count showed 9,600 white cells with 80 per cent polymorphonuclears, 20 per cent lymphocytes, 3,750,000 red cells, 71 per cent hemoglobin.

Early in September, the patient became progressively weaker, with frequent attacks of vomiting. He had tarry stools. The pain in the epigastrium, left lower ribs, and dorsal spine was at times intolerable, and the visible or palpable tumors became rapidly larger. The treatment consisted essentially of sedatives and intravenous infusions. Death occurred Oct. 19, about three months following the patient's accident.

On postmortem examination a fungating carcinoma of the stomach was found, with metastases in the regional lymph nodes, liver, right 1st and 2nd and left 6th, 7th, 11th, and 12th ribs, both clavicles, the sternum, and the 6th and 7th thoracic vertebrae. A tumor thrombus was present in the portal vein. On careful examination, however, there was no gross or microscopic evidence of tumor cells in the fractured 1st lumbar vertebra.

Comment: The important feature of this case is the presence of a definitely established compression fracture of the first lumbar vertebra which, on radiographic examination fifty days later, showed no demonstrable evidence of change. On postmortem examination widespread metastases were present in many bones, among them two dorsal vertebrae. No metastasis was found, however, in the first lumbar, which had suffered a crushing injury several months earlier.

DISCUSSION

According to Segond, Thiem, Lubarsch, and Ewing, in determining a probable relationship between injury and tumor, the following requirements should be fulfilled:

1. Establishment of the injury with moral certainty (authenticity of trauma).
2. Presence of demonstrable tissue changes caused by the injury, *e.g.*, laceration, fracture, etc. (adequacy of trauma).
3. Exclusion of pre-existing neoplasm with the aid of physical and radiographic examination (previous integrity of the injured area). Absolute proof as to the absence of a small pre-existing tumor is very difficult.
4. An interval of reasonable length between the trauma and the first appearance of the tumor (from three weeks to three years or more in certain cases).
5. Presence of so-called "bridging symptoms"; *i.e.*, the symptoms of the injury should be continuous with those of the neoplasm. This requirement is of minor significance.
6. Presence of the tumor at the point of the trauma.
7. Definite establishment of the diagnosis of a neoplasm, preferably with the aid of a microscopic examination.

The first case, presented above, revealed three tumor areas which apparently had received previous injuries. The tumor in the *left leg*, supposedly preceded by a bruise, evidently fails to meet postulates 1 and 2 and probably 3. Proof of the injury and the bruise produced by this are insufficient; they were claimed only by the patient. Nor has the possibility of a pre-existing growth been excluded. The growth in the *right knee* region, primarily in the soft tissues of the distal thigh and involving the femur secondarily, cannot be said with any certainty to fulfill postulate 6. The brush burns and lacerations of the thigh were located somewhat above the site of the subsequent growth and there was complete healing of the wounds with no tumor nodules in the scars. Consequently, although it is hard to say definitely, this metastasis probably did not develop at the exact point of the trauma. An even more difficult problem is the determination of a possibly post-traumatic tumor formation at the fracture of the

right radius. At first glance, practically all the requirements for compensability are present in this instance. The laceration of the right forearm and the fracture of the radius completely fulfill postulates 1 and 2. The physical and x-ray examination on the day of injury excluded the presence of a pre-existing growth. About four weeks elapsed between the injury and the first signs of the neoplasm. As to the bridging symptoms, this requirement was also well covered with the continuous presence of the fracture and the soft-tissue changes. The growth appeared at the site of the fracture, the wrist being an unusual location for metastasis. The diagnosis of a neoplasm was definitely established by microscopic examination. Regarding the dubious status of a pre-existing tumor (postulate 3), naturally the possible presence of tumor cells in the area at the time of the accident—perhaps demonstrable only microscopically—cannot be excluded. To prove or disprove this point is extremely difficult. Regarding this question, however, the studies of Schmidt, Warren, and others deserve consideration. These investigators pointed out that tumor emboli may become organized and disappear or remain latent over long periods without establishing true metastases. This occurrence would, of course, still favor the possibility of at least a traumatic aggravation.

On the first hearing, before the development of numerous additional subcutaneous and intramuscular metastases, our testimony was in favor of the plaintiff. The trauma was believed to have been a definite contributory factor in the full development of the secondary tumor. This statement, after the apparent fulfillment of all the seven postulates listed above, was supported also by the following facts: (1) the location of the metastasis was an unusual one for a secondary neoplasm; (2) the wrist tumor appeared first, before the development of other peripheral metastases; (3) its growth was unusually rapid and painful.

A closer study of this metastasis, together with the subsequent development of additional secondary tumors, resulted in some change in our opinion. Fulfillment of postulate 6—that the growth be at the exact point of injury—needed a more careful investigation. There is no doubt that the tumor was located at the site of the fracture of the radius. It arose, however, in the soft tissues, with gradual involvement of the bone over a large area, after the soft-tissue mass had reached considerable proportions. Exactly the same picture developed in the left leg, left forearm, and right lower thigh. All these regions showed originally a soft-tissue growth with secondary infiltrative invasion of the underlying bone. In roentgenographic appearance the bone lesions were all alike. In the left forearm, in addition to the periostitis, small flakes of calcification, apparently detached parts of the tumor-invaded periosteum, were demonstrable in the soft-tissue tumor adjacent to the bone, closely resembling the small areas of calcification in the tumor at the right wrist. The periosteal reactive triangle in the right radius was closely imitated in the right femur. In other words, the appearance of the growth in the right wrist region was reproduced in several other areas.

In regard to the lodgment of tumor cells, the tissues damaged in the region of the subsequent metastasis in the right wrist were the following: *skin*, with well visualized lacerations; *bone*, with distinctly demonstrable fracture; *subcutaneous tissues*, including *muscles*. The exact location of the trauma is difficult to demonstrate in the subcutaneous layers, especially in the presence of a diffuse, not noticeably localized soft-tissue swelling such as was present in this case. A few months after the injury a complete healing of the lacerations could be observed, with no evidence of tumor nodules in the scar. Furthermore, the metastasis was not localized in the bone in its fractured area; instead, it originated in the subcutaneous tissues around the fracture, in exactly the same manner as in several other, evidently non-traumatized regions (left forearm). Had

the secondary tumor developed in the fractured bone first, which it did not do, the evidence would have probably been much more indicative of a definite traumatic relationship. As it is, postulate 6 is only partly or perhaps not at all fulfilled in this instance.

For further proof against any traumatic influence, and in view of the difficulty of localizing injuries in the subcutaneous layers, an experimental traumatization of these tissues was produced in a selected area. In spite of the favorable location of this trauma, no secondary tumors ever developed in this area.

In connection with these observations, we should like to emphasize the necessity of carefully following the entire course of the disease in similar suspected cases. Perhaps another requirement could be added to Segond's seven postulates: a supposedly traumatic metastasis should sometimes present a different mechanism in its development in comparison with other secondary tumors, *e.g.*, the occurrence of a post-traumatic subcutaneous metastasis in the presence of generalized bone involvement.

Other findings were opposed to the relationship of injury and the localization of metastasis. (1) The sprain of the left thumb, the surgical incision for the removal of the small neurofibroma in the left forearm, and repeated intravenous and subcutaneous injections failed to localize metastases. It is interesting to note that Ewing reported a case in which, he believed, hypodermic injections in the deltoid muscle probably caused the appearance of metastases of a testicular carcinoma. (2) The stump of the right arm never revealed a secondary growth either in the soft tissues or in the bone, although a large subcutaneous nodule developed in the same arm just below the level of the axilla. (3) No tumor cells were discovered at the site of the crushing vertebral injury, described in Case 2, after three months, in spite of the presence of widespread metastases involving some of the apparently uninjured dorsal vertebrae. (4) The extreme rarity of similar cases is also a helpful factor in this respect. There is a great probability that many patients with cancer, and even with generalized metastases, suffer injuries of different kind and degree; yet suggestive signs of post-traumatic tumor formation are only occasionally found, although the claim is frequently made by the laity.

The majority of the findings, as has been shown, are more against than in favor of post-traumatic tumor formation. Actually, there are only a few vague signs which favor a traumatic relationship. Of these, the first appearance of the tumor in the right wrist, its seemingly rapid growth, and the possible aggravation of a small, pre-existing metastasis by the injury call for some consideration.

Regarding the first appearance of the growth, it is worth while to remember that an additional, apparently non-traumatic subcutaneous nodule was also present in the right forearm at the same time. As to the rapid increase in size, a comparative study of other peripheral metastases, developing later, showed a similar rate in growth after their detection. The presence of *Staphylococcus albus hemolyticus* in the right wrist tumor also deserves attention; this low-grade infection may have contributed somewhat to the slight difference in the rate of growth. All the metastases with secondary bone involvement were unusually painful, especially in the beginning of bone infiltration.

To prove or disprove the possibility of aggravation is extremely difficult. According to F. C. Wood, however, biopsies on transplanted mouse carcinomas failed to reveal any acceleration of the rate of tumor growth. Lubarsch, as well as other observers, recognized the fact that untraumatized tumors do not grow with any regularity; considerable periods of rest may alternate with active periods of growth.

A review of those reports in the literature which favor a relationship between trauma and tumor metastases has shown that most of the cases failed to fulfill Segond's seven postulates. Others appar-

ently have not been observed long enough for proper evaluation. The records are particularly incomplete as to adequate study of the affected organ at the time of the trauma with regard to the extent and exact location of the injury, as well as the exclusion of a pre-existing tumor. Many reported cases are actually pathological fractures or "pathological traumas." It is a question whether the animal experiments of Jones and Rous, Foulds and others are comparable with the conditions of injured human tissues. Lubarsch, and later Tinozzi, however, failed entirely to localize metastases by fracturing bones of tumor-bearing mice and rats.

To reach a final decision on the interrelation of mechanical trauma and metastasis is greatly hindered by the chaotic status of the many problems of ordinary non-traumatic metastatic spread. Nevertheless, after a careful study of these cases, as well as the pertinent literature, it is felt that accidental trauma must play a very insignificant part, if any, in the formation of secondary tumors. The occasional suggestive reports of such a connection are probably more a matter of coincidence than actual relationship.

SUMMARY

Two cases of generalized carcinomatosis were studied with a view to determining the influence of various mechanical injuries on the formation of metastases. Lacerations of the skin, repeated subcutaneous and intravenous injections, surgical amputation of the forearm, linear as well as compression fractures failed to result in the localization of secondary tumors. One post-traumatic and several supposedly post-traumatic metastases seemingly fulfilled all the requirements of Segond for the establishment of a definite relationship between accidental injury and metastatic cancer. On further observation, however, it became evident that we were dealing with an unusual type of metastatic spread from a primary lung carcinoma with preferential involvement of the subcutaneous tissues and muscles. The practically identical appearance of several intramuscular and subcutaneous metastases was suggestive evidence against any traumatic influence. A subsequent experimental blunt traumatization, affecting mainly the subcutaneous structures in an apparently favorable location, failed to result in the formation of a metastasis. It thus appears to us that the unknown laws of metastasis have had an overwhelming—probably an exclusive—influence in the localization of the secondary deposits, possibly being entirely indifferent to the incidental presence of multiple traumata. The various reports in the literature are also lacking in satisfactory scientific support of a definite causal relationship. In medicolegally doubtful cases, an additional requirement to the usual postulates of Segond and others has been suggested.

NOTE: The writer wishes to express his appreciation to Drs. J. Durkin, C. Haines and J. Denton for certain data in connection with these cases, as well as to Drs. J. Bayliss and S. Tager for their helpful suggestions.

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Million-Volt Isodose Curves for Angulated Beams[1]

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IN THE RADIATION treatment of deep-seated cancer, particularly in the pelvis, the beam of x-rays is frequently angulated away from the normal so as to produce a cross-firing effect on the lesion. Unless there is compensation made by the insertion of a bolus into the angle formed by the end of the treatment cone and the skin of the patient, the distribution of the radiation is seriously distorted. This effect has been carefully investigated by May (1) for 180 kv. (constant potential) and a filter of 0.8 mm. copper and 1.0 mm. aluminum. He shows that when the air space is filled with bolus, no distortion occurs with angulation and the normal isodose curve applies.

Since the million-volt generator at this Institute is to be used for cross-firing and angulation without bolus, it became necessary to establish the distortion effect resulting from various degrees of angulation for an x-ray beam of 9.0 mm. H.V.L. for a field 10 × 15 cm. at 70 cm. distance. Measurements were made under these conditions, utilizing as an absorbing medium a presdwood phantom in conjunction with a thimble-type ionization chamber. A row of cylindrical recesses were drilled at various depths perpendicular to the surface of the phantom to permit the insertion of the ionization chamber into the beam of radiation. Plugs were provided for insertion into all of the recesses except the one in use, so that the absorbing medium would be uniform. Since our million-volt generator has no provision for angulation of the beam, it was necessary to angulate the phantom at the end of the treatment cone as desired. Provision was made for both horizontal and vertical movement of the phantom so that the row of recesses could be moved into any desired position in the beam without varying the distance or the angle between the end of the treatment cone and the upper surface of the phantom. The dimensions of the phantom were sufficient to confine the entire beam within the phantom in all positions.

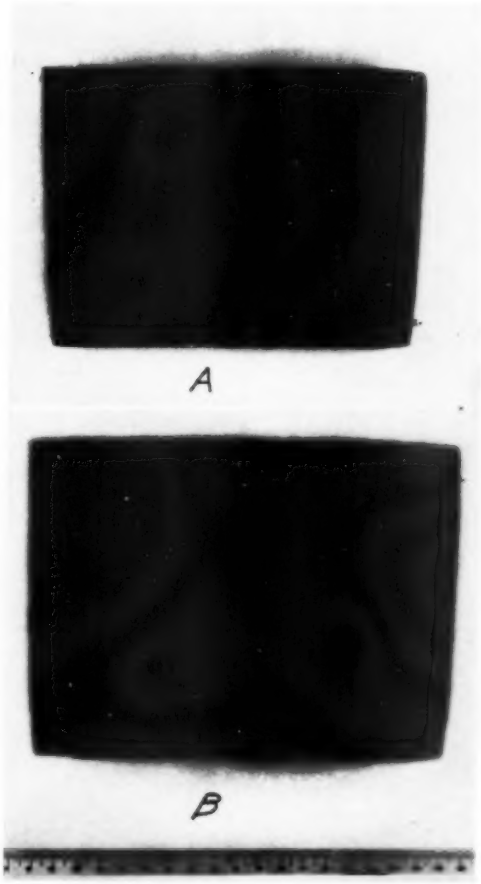

Fig. 1. Films exposed to a beam of x-rays at the surface (A) and at 10 cm. depth (B) with a presdwood phantom, 10×15 cm. field, 70 cm. distance, angulation 22.5°.

Photographic films were placed on the surface and at various depths with the phantom at different angles. This per-

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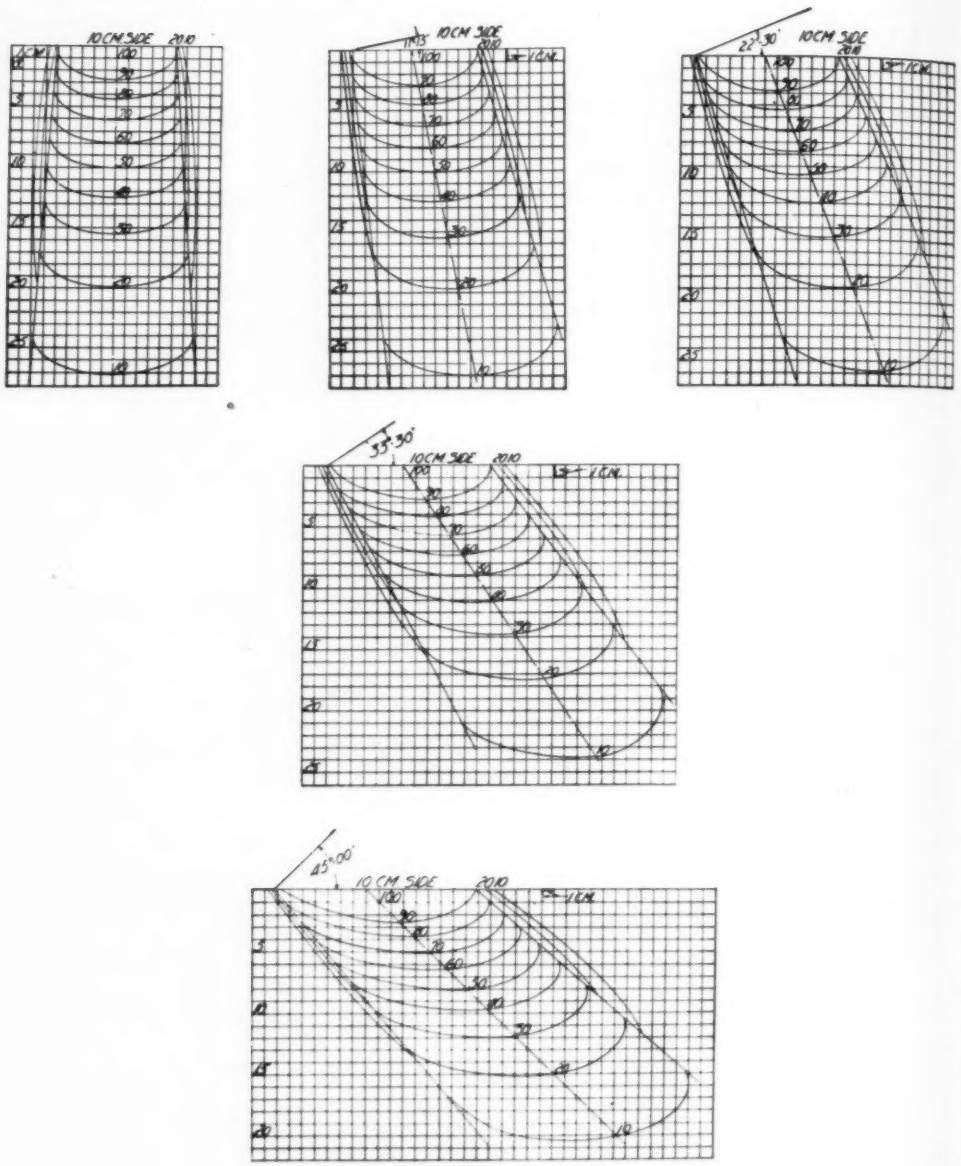

Fig. 2. Isodose curves for million-volt x-ray beams angulated at 0°, 11.15°, 22.5°, 33.5°, and 45°.

mitted a satisfactory method of outlining the beam and shows, as pointed out by Jones (2), that the cut-off at the edges of the beam are fairly sharp even at depth (Fig. 1). Since the central ray would not be the center of the treatment area at the surface or at depth, its location at different depth levels was also determined by means of films.

With the upper surface of the phantom making a definite angle with the end of the treatment cone, ionization measurements

were made in each of the cylindrical recesses at depth and referred to the intensity at the center of the surface as 100 per cent. The ionization chamber was half submerged on the surface. The phantom was then shifted and a new series of measurements was made with the recesses in a different position. The depth intensities for each perpendicular row of recesses were plotted, and a curve was drawn through the plotted points, permitting even depth intensities to be obtained. These were used in constructing the final isodose curves.

The isodose curves for a 10 × 15 cm. treatment area at 70 cm. distance, where the angle between the lower surface of the treatment cone and the surface of the phantom is 0, 11 1/4, 22 1/2, 33 1/2 or 45 degrees, are shown in Figure 2.

It is apparent from an inspection of these isodose curves that, as the angle between the bottom of the treatment cone and the surface of the phantom increases, there is a progressively greater distortion of the beam. Furthermore, it may be observed that, on a perpendicular line below the surface, there is a decrease in depth dose with increasing angle. Along the central ray, however, there is a small but definite increase in depth dose with increasing angle. Table I shows the depth in centimeters along the central ray of the 10 per cent isodose line.

TABLE I: DEPTH OF 10 PER CENT ISODOSE LINE

Angle	Depth
Normal	27.2 cm.
11.25°	27.7 cm.
22.5°	28.1 cm.
33.5°	28.4 cm.
45.0	28.6 cm.

A comparison of the intensities at depth produced by an angulated beam applied with and without bolus is of interest. The angulated isodose curve was applied to a diagram similar to the one shown in Figure 3, with the surface line (100 per cent) coinciding with line *MP*. The depth intensities were estimated at the various points indicated on the diagram. The normal isodose curve was similarly applied

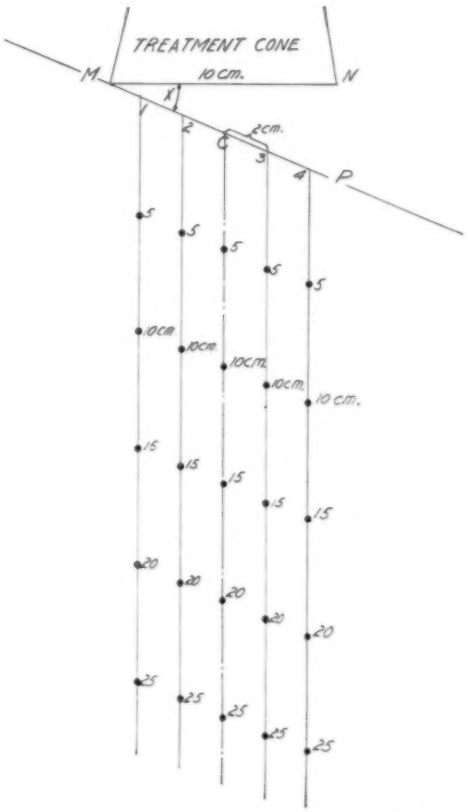

Fig. 3. Diagram showing points at which depth intensities were estimated in order to compare angulated beams used with and without bolus.

to the same diagram, except that in this case the surface line coincided with the line *MN*, since the angle *PMN* would be filled with bolus. Under these conditions the line *MP*, representing the skin of the patient, received less than 100 per cent. Therefore, in order to compare the two sets of figures on a common basis, it was necessary to evaluate the second set, considering the value on the surface at point *C* to be 100 per cent, and correct the other values in proportion.

The results of these calculations were tabulated. Along line *1*, there was practically no difference between the two methods. Along line *2*, there was a slight increase in depth dose without bolus as compared to those with bolus. This difference became increasingly evident for

TABLE II. COMPARISON OF DEPTH INTENSITIES FOR ANGULATED BEAMS (H.V.L. 9.0 Cu) WITH AND WITHOUT BOLUS

Depth (cm.)	Line C			Line 4		
	With Bolus	Without Bolus	Per Cent Gain	With Bolus	Without Bolus	Per Cent Gain
			Angulation of Beam 11° 15′			
10	46.9	50.5	7.7	41.7	46.8	12.2
15	29.5	31.8	7.8	26.0	29.1	11.9
20	18.6	19.9	7.0	16.2	18.2	12.3
25	11.7	12.6	7.7	10.1	11.3	11.9
			Angulation of beam 22° 30′			
10	44.8	52.0	16.1	37.3	47.3	27.8
15	28.2	32.9	16.7	23.1	29.9	28.4
20	17.8	20.7	16.3	14.5	18.6	28.3
25	11.2	13.1	16.9	9.0	11.6	28.8
			Angulation of beam 33° 30′			
10	42.8	53.9	26.0	32.0	48.2	50.7
15	27.0	34.2	26.6	20.2	30.8	52.5
20	17.0	21.7	27.6	12.7	19.3	52.0
25	10.7	13.6	27.1	8.0	12.0	50.0
			Angulation of beam 45°			
10	40.8	56.0	37.3	30.8	51.2	66.2
15	26.1	36.0	38.0	19.2	32.0	66.7
20	16.5	22.8	38.2	11.9	20.1	69.0
25	10.5	14.5	38.0	7.4	12.5	69.0

lines *C*, *3*, and *4*. The actual values for lines *C* and *4* are shown in Table II for depths below 10 cm.

The percentage increase in depth intensity when no bolus is used, with a beam of x-rays, H.V.L. 9.0 mm. copper, is shown in Table II. The variation in the individual brackets is due to the impossibility of reading the isodose curve in the second decimal. The agreement is sufficiently close, however, to indicate that there is a definite increase in depth intensity without bolus and that for any one angle the percentage of gain increases with increasing distance from the point of contact of the treatment cone and the surface. It is impossible to draw any conclusions from the table regarding the percentage increase of depth intensity with increasing angulation because the points of estimation of dosage vary with each degree of angulation.

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CASE REPORT

Rhabdomyosarcoma of the Extremities[1]

ROBERT L. GARBER, M.D.[2]

Rhabdomyosarcomata are of rare occurrence and widespread distribution, with the greatest incidence in the genito-urinary tract (1). Rakov (2) reported 17 cases arising in the striated muscles of extremities in a period of nine years. Glasunow, MacCallum, and Geschickter (quoted by Rakov) each reported 2 cases arising in the extremities verified by histopathological examination.

Age and sex are of no etiologic significance. The lower extremities are the most frequently affected. The individual muscles of the extremities most often involved are the quadriceps of the leg and the biceps of the arm. Regional involvement of the lymph nodes is rare. Distant metastasis, however, *via* the lymphatic and vascular routes is frequently observed.

The most striking feature of the natural history of rhabdomyosarcomata is their tendency to recur locally following surgical extirpation. Rakov (2) in his series found the interval between removal and recurrence to vary from a few weeks to several years, the longest being three and a half years. No characteristic roentgenographic findings are described.

The therapeutic aspects of this entity are concerned with radical surgery combined with deep roentgen therapy. Leucutia (3) reports a series of 3 cases of rhabdomyosarcoma (in a total of 3,000 malignant tumors of all types) none of which was influenced by radiation therapy. Frank *et al.* (4) report one case arising in the sternocleidomastoid muscle with a three-year survival after radical excision and two series of postoperative radiation (approximately 7,000 r in air with 160 kv.p., 8 ma., 50 cm. T.S.D., 0.25 mm. Cu + 1.0 mm. Al). Rakov (2) regards radical excision as the treatment of choice. He found preoperative or postoperative radiation to be without apparent benefit.

Fig. 1. Roentgenogram of the right shoulder, showing bony destruction of the head and upper third of the humerus along its lateral aspect with spicules projecting into the adjacent soft tissue mass.

J. L., white male, 68 years of age, six months prior to admission experienced pain in the left shoulder, at first on movement and then constantly. Soon afterward a progressively enlarging mass in relation to the outer aspect of the shoulder was discovered. General malaise and weakness progressed, and total disability resulted. The family history, past history, and history by systems were not contributory.

The patient was fairly developed and well nourished, with a large firm mass in relation to the upper end of the humerus. There was definite limitation of motion and pain was constant. The heart and lung findings were within normal limits. Blood pressure was 142/78; temperature 99.2; pulse 92; respirations 20. The only positive neurological finding was anesthesia of the volar surface of the entire left forearm.

X-ray examination of the right shoulder showed a large irregular area of destruction in the upper and lateral humerus with bony spicules radiating into the soft-tissue mass (Fig. 1). The appearance suggested a primary osteogenic sarcoma. Further radiography showed no evidence of bony or pul-

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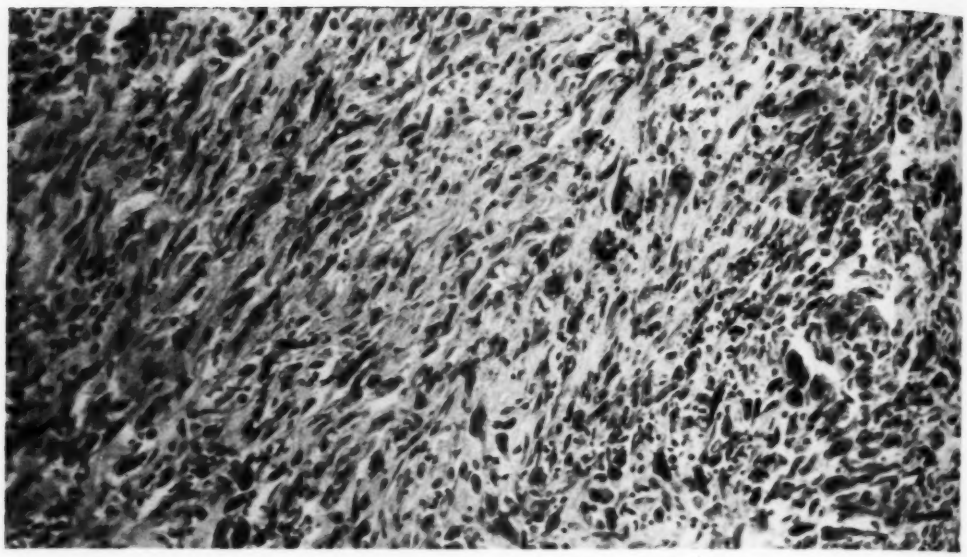

Fig. 2. Photomicrograph of biopsy specimen, showing cellular pleomorphism, and bizarre and giant nuclei.

monary metastases. Medical treatment was symptomatic.

The patient received a course of radiation therapy through anterior and posterior ports (15 cm. in diameter). In two weeks, 1,600 r in air were given to each port. Factors were 200 kv., 0.5 mm. Cu + 1.0 mm. Al, 20 ma., 50 cm. T.S.D., H.V.L. 0.9 mm. Cu.

Two weeks following the course of therapy no significant regression was observed either on physical examination or serial roentgenography.

Surgical exploration of the shoulder was now undertaken. It revealed a large hemorrhagic tumor, the size of a grapefruit, involving the upper third of the humerus, chiefly the lateral and anterior aspects. A small biopsy specimen was taken. The upper third of the humerus was dissected freely and partially resected to remove the involved bone and the adjacent soft-tissue mass.

Grossly, the specimen consisted of the proximal fourth of the humerus which was being excavated by a neoplasm about 10 cm. in diameter. The bulk of the tumor lay about the bone. It was imperfectly encapsulated and some small pieces of skeletal muscle and fat were attached to the surface. The cut surface showed numerous areas of hemorrhage and necrosis.

The sections (Zenker fixation) showed marked cellular pleomorphism and many giant multinucleated cells (Fig. 2). Primitive striations were seen in a few cells, after prolonged search. Areas of degeneration, necrosis, and hemorrhage were present. The exact origin of the neoplasm cannot be determined but it must be assumed to have arisen in the skeletal muscle, making it a rhabdomyosarcoma.

The wound healed promptly, and the patient was dismissed on the ninth postoperative day. Six months later he was in satisfactory general condition, although the use of the limb was restricted.

SUMMARY

1. A case of primary rhabdomyosarcoma arising in an extremity, histopathologically established, is presented, along with a review of the literature.

2. Radical surgery is the only effective treatment.

NOTE: Acknowledgment is made to Dr. Wm. M. German, Director of Pathology, Good Samaritan Hospital, for the pathological report, and to Mr. Joseph Homans, Department of Medical Photography, College of Medicine, University of Cincinnati, for the photomicrograph.

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EDITORIAL

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John D. Camp, M.D., Associate Editor

Political Realism

While continuing opposition to proposed impractical revolutionary changes in the habits of medical practice, it behooves the medical profession to examine the situation in which it finds itself, without the bias of physician, patient, or social reformer. In the language of the day, we should be "realistic." Are there defects in our methods, or is the present agitation merely a symptom of the times? The answer is, both.

The economics of medicine are not satisfactory. The cost of medical care is so high that the poor cannot pay it. Even the fairly well-to-do have to stretch the nickels left after payment of taxes to meet the bills from the doctor and hospital, with its extra charges for operating room use, administration of the anesthetic, special medication, etc. Only the rich can face the costs of sickness with equanimity, and they are often grossly over billed through the operation of the "charge-according-to-ability-to-pay" system.

Considering his many unproductive years of preparation, his long hours of work, and the great responsibility that he carries, the doctor cannot be said to be overpaid. Medicine, more than any other profession, operates its own charitable system. Every physician treats many patients without cost, some because they cannot pay and, alas, some because they will not. In the effort to make both ends meet, the habit of overcharging the rich developed, making them the involuntary sharers of the bills of the poor. This unsystematic method of distributing expense—unsatisfactory at best—will become still more difficult as medical science advances and costs of medical care become correspondingly higher.

The geographical distribution of medical care is another problem demanding solution. Urban centers are well provided for, but many small towns and rural sections lack an adequate supply of physicians and hospitals. Even some of our more populous states are without essential specialists in rural districts. The young men who have been trained in medical centers where complete hospital and special facilities are available are not interested in practising where these things are lacking. Thus the urban supply of physicians is increasing while the situation in the rural areas grows worse.

The free choice of a physician is becoming a myth. The well-to-do city dweller can choose the physician he wants; the poor man cannot, so he does without or goes to a free clinic, where he accepts treatment from a staff physician in whose selection he has had no voice. The rural dweller, though he can afford any fee, usually has a limited choice. Although his local practitioner may be doing a fine job with the facilities he has, the lack of special services is a serious handicap.

Again, a vast amount of public health service has fallen to the lot of the individual practitioner. This does not receive the attention it should, not because the doctor is unwilling, but because he lacks facilities and time, and there is no established acceptable method of defraying the cost. Periodic examinations of apparently healthy people are generally advocated; yet how little is this fundamental preventive measure used. It must be admitted

that many times when the patient is enlightened enough to arrange for it, the examination is inadequate. The doctor is so busy with sick patients that he cannot take the time to do a really thorough job, and when such an examination is incomplete, it is worse than none at all.

The selective service examinations have revealed a distressingly high percentage of physical defects among our population. This lends emphasis to the value of periodic examinations and of surveys of certain groups for particular defects, such as the tuberculosis-finding programs now being advocated. Not only has the medical profession failed actively to encourage these examinations, but it has not been noticeably cooperative once they have been started. Practically all physicians capable of taking part are too busy to take on this extra and time-consuming job. Some antagonism has been aroused, also, by the methods of financing used. The medical profession rightly believes that surveys of gainfully employed people should not be paid for by a charitable organization. The remuneration offered to the doctor for his part in the survey is often much too little for the skill, knowledge and time which he contributes.

Doctors have been too busy caring for their individual patients to correct these obvious defects in methods of providing medical care. Sincere but sometimes inadequately informed reformers, therefore, have brought forth various schemes for correcting them. Whether we approve or not, there is a tendency toward governmental regulation under the guise of governmental assistance, and we are confronted with some unhealthy propositions, largely because we, who should be the leaders in improving medical care, have been too busy to take our proper place.

Organized radiology has been active and constructive in meeting some of the problems relating to radiologists. The American Medical Association and the National Physicians Committee have concerned themselves with some of the problems of general medicine. On the whole, however, the attitude is still too general, too negative, and active interest and participation on the part of individual practitioners is sadly lacking. There has been, and still is, a tendency to let the societies fight the battles of the individual. These may be the result of his own failure to give adequate service to his patients and to cooperate adequately with his fellow practitioners, but when trouble arises he turns to his local or national society for aid. When national problems arise, he is willing to leave these, too, to the larger group, and his interest and support are at best half-hearted.

This lack of a unified opinion behind our leaders and spokesmen is a serious handicap to them. In some measure, it may account for the predominantly negative stand that organized medicine has been taking. If we would insure improved care for the public and better conditions of practice for ourselves, it is imperative that we shed our indifference. The radiologist, the surgeon, the otolaryngologist, the general practitioner, and all the other specialists must get together, formulate a positive solution for these problems, and encourage their correction. An "anti" attitude cannot much longer be successful. A "pro" attitude must replace it.

SYDNEY J. HAWLEY, M.D.

ANNOUNCEMENTS AND BOOK REVIEWS

JOINT MEETING AMERICAN ROENTGEN RAY SOCIETY and RADIOLOGICAL SOCIETY OF NORTH AMERICA

Attention is again called to the joint meeting of the American Roentgen Ray Society and the Radiological Society of North America to be held in the Palmer House, Chicago, Sept. 24 to 29, 1944, announcements of which appeared in the March and April issues of RADIOLOGY.

Titles and abstracts of papers to be presented should be submitted to Dr. Lyell C. Kinney (1831 Fourth Ave., San Diego 1, Calif.) or Dr. Eldwin R. Witwer (Harper Hospital, Detroit 1, Mich.) before July 1. Prospective commercial exhibitors should make application for space to Dr. Lawrence Reynolds (10 Peterboro, Detroit 1, Mich.), and those planning to present scientific exhibits should communicate with Dr. Clarence Hufford (421 Michigan St., Toledo 2, Ohio) at the earliest possible date.

An outline of the Refresher Courses, which will begin Sunday, Sept. 24, will appear in the next issue of RADIOLOGY.

AMERICAN BOARD OF RADIOLOGY

The American Board of Radiology will conduct examinations on Sept. 22, 23, and 24 at the Palmer House, Chicago. Those wishing to be examined at that time must have their application on file by August 1, 1944.

B. R. KIRKLIN, *Secy.*
Rochester, Minn.

AMERICAN CONGRESS OF PHYSICAL THERAPY

The twenty-third annual scientific and clinical session of the American Congress of Physical Therapy will be held Sept. 6–9, at the Hotel Statler, Cleveland, Ohio. Information concerning the instruction course and program of the convention may be obtained by addressing the American Congress of Physical Therapy, 30 North Michigan Ave., Chicago 2, Illinois.

In Memoriam

MAURICE FRANCIS DWYER, M.D.

1889–1944

Maurice Francis Dwyer, M.D., of Seattle, Wash., a member of the Radiological Society of North America and Counselor for the State of Washington, died Feb. 28, 1944. The following account of Doctor Dwyer's life is reprinted from the *Bulletin* of the King County Medical Society (Washington).

"Maurice Francis Dwyer was born March 10, 1889, in St. Louis, Missouri, and much of his boyhood was spent in Dawson, Yukon Territory. His degree of A.B. was earned at Gonzaga University, from which institution he graduated in 1910. Passing then to St. Louis University he received a degree of Doctor of Medicine in 1914. Licensed to practice in Washington in 1914, he interned at Providence Hospital in Seattle. Shortly afterward he

MAURICE FRANCIS DWYER, M.D.

associated himself in practice with the late J. Tate Mason. Early becoming interested in radiology, he was an early and distinguished member of that specialty group.

"During the period following World War I, when there was a vital urge for betterment in clinical medicine, and improvement in hospital facilities, his was a large part in the construction of the Virginia Mason Hospital and in the formation and direction of the Mason Clinic. These associations were terminated only by his death.

"He was a member of the King County Medical Society, Washington State Medical Association, American Medical Association, Washington State Radiological Society, Fellow of the American College of Physicians, Fellow of the American College of Radiology, member of the Radiological Society of North America, and licentiate of the American Board of Radiology. The Knights of Columbus and the Rainier Club numbered him among their valued members. An indefatigable worker and possessed of a keenly inquiring mind, he contributed freely to local and national scientific journals.

"No one knows or has ever said evil of him. He was kindly, fair and open-minded, and blessed with a sunny disposition which illness failed to spoil. His relations with his family, his patients, his professional and business associates, and the world in general were as nearly ideal as it is ever our privilege to see. His loss will remain a personal one and produces an aching void in his intimates' hearts. The passing of one with his ideals and principles is a stunning loss to a world greatly in need of such men.

"He was a Christian in the highest sense of the word.

"G. A. D."

EDWARD REGINALD MORTON, M.D.
1867-1944

Dr. Edward Reginald Morton, of Gullane, Scotland, a corresponding member of the Radiological Society of North America, died on Jan. 21, 1944.

Doctor Morton studied medicine at Trinity College, Ontario, and in Edinburgh and established himself in London, specializing in radiology, while the science was still in its beginnings. The following account of his career is from the *Lancet*, Feb. 19, 1944.

"For six years he was in charge of the x-ray and electricity department of the London Hospital, where he devoted himself to developing the then very crude apparatus available. In 1909 he accepted an appointment at the West London Hospital which he held until he retired; along with Souttar and Harman his postgraduate teaching there made a memorable period in medical education. The last war, during which he was radiologist to the 2d London (General) Military Hospital, separated him from his colleagues abroad but as soon as it was over he visited his friend Professor Schrumpf at Erlangen and returned to introduce into this country deep x-ray therapy for carcinoma of the uterus. As a result of his enterprise the West London was the first of our hospitals to be equipped with the apparatus. In 1922, accompanied by the late General Fotheringham, RCAMC, Morton toured Canada and the United States lecturing on the new technic. In 1926 he retired to his summer home at Gullane where he led a happy and active life which, till his last illness, was unclouded by ill health, for he was one of the few x-ray pioneers who suffered only minor damage from the rays. His *Medical Electricity and Radiography* appeared first in 1910 and a second edition of his *Textbook of Radiology* was published in 1918."

Book Reviews

MEDICAL PHYSICS. Editor-in-Chief, OTTO GLASSER, Ph.D., Head of Department of Biophysics, Cleveland Clinic Foundation; Professor of Biophysics, Frank E. Bunts Educational Institute; Consulting Biophysicist, University Hospitals of Cleveland, Cleveland, Ohio. Associate Editors: *Anatomy:* Normand L. Hoerr, M.D., Ph.D.; *Bacteriology:* Otto Rahm, Ph.D.; *Biometrics:* Charles P. Winsor, Ph.D.; *Biophysics:* Otto Glasser, Ph.D.; *Dermatology:* George W. Binkley, M.D.; *Hematology:* Eric Ponder, M.D., D.Sc.; *Medicine:* Russell L. Haden, M.D.; *Neurology:* W. James Gardner, M.D.; *Nuclear Physics:* Robley D. Evans, Ph.D.: *Ophthalmology:* Albert D. Ruedemann, M.D.; *Optics:* W. B. Rayton, D.Sc.; *Orthopedics:* James A. Dickson, M.D.; *Otolaryngology:* Paul M. Moore, Jr., M.D.; *Pathology:* Harry Goldblatt, M.D., C.M.; *Pediatrics:* Norman C. Wetzel, M.D.; *Photography:* Leo C. Massopust; *Physical Chemistry:* Francis M. Whitacre, Ph.D.; *Physical Therapy:* Walter J. Zeiter, M.D.; *Physics (Instruments and Methods):* John G. Albright, Ph.D.; *Physiology:* Harold D. Green, M.D.; *Radiology:* Harry Hauser, M.D.; *Surgery:* Frederick R. Mautz, M.D.; *Urology:* Charles C. Higgins, M.D. A volume of 1,744 pages, with numerous illustrations. Published by The Year Book Publishers, Inc., Chicago. Price $18.

This volume is one of the most comprehensive treatises on the fundamental physical aspects of medicine in all its branches that has ever been printed. Much of the subject matter could as well be called medical physiology.

The Editor and his 22 Associate Editors, each a specialist in his field, have attempted to embody in one volume an encyclopedic reference book, a textbook for students, and a working instrument for those interested in applying the principles of physics to medicine—a rapidly increasing group. The work is of encyclopedic character not only in bulk and content but also in the arrangement of the material, which is strictly alphabetical, beginning with Air Conditioning on page 1 and continuing to Weighing on page 1,675. Each article carries its own list of references, and many are illustrated.

In addition to the conventional Table of Contents, the Editors have wisely supplied a Classified Table of Contents, in which the articles are grouped under the main headings of Anatomy, Bacteriology, Biometrics, Biophysics, Dermatology, Hematology, Medicine, Neurology, Nuclear Physics, Ophthalmology, Optics, Orthopedics, Otolaryngology, Pathology, Pediatrics, Photography, Physical Chemistry, Physical Therapy, Physics (Instruments and Methods), Physiology, Radiology, Surgery, and Urology. This is an excellent guide not only for the specialist in any field but also for the student, furnishing what amounts to a series of study courses in the physical aspects of the various specialties.

A subject index and an author index serve as a further aid in locating desired information.

This book can be unreservedly recommended to all those who wish to keep abreast of the progress that has been made in medical physics, which is assuming a vital role in every branch of practice. It is a must for every medical library and hospital.

RADIOLOGICAL SOCIETIES OF NORTH AMERICA

Editor's Note.—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

UNITED STATES

Radiological Society of North America.—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse 2, N. Y.

American Roentgen Ray Society.—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

American College of Radiology.—Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago 11, Ill.

Section on Radiology, American Medical Association.—Secretary, J. T. Murphy, M.D., 421 Michigan St., Toledo 2, Ohio.

ARKANSAS

Arkansas Radiological Society.—Secretary, J. S. Wilson M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

CALIFORNIA

California Medical Association, Section on Radiology.—Secretary, Earl R. Miller, M.D., University of California Hospital, San Francisco, Calif.

Los Angeles County Medical Association, Radiological Section.—Secretary, Roy W. Johnson, M.D., 1407 South Hope St., Los Angeles. Meets second Wednesday of each month at County Society Building.

Pacific Roentgen Society.—Secretary, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Meets annually during meeting of California Medical Association.

San Diego Roentgen Society.—Secretary, Henry L. Jaffe, M.D., Naval Hospital, Balboa Park, Calif. Meets first Wednesday of each month.

San Francisco Radiological Society.—Secretary, Martha Mottram, M.D., Suite 1789, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., in Toland Hall, University of California Hospital, from January to June; at Lane Hall, Stanford University Hospital, July to December.

COLORADO

Denver Radiological Club.—Secretary, A. Page Jackson, Jr., M.D., 304 Republic Bldg., Denver 2. Meetings third Friday of each month at the Denver Athletic Club.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Secretary, Max Climan, M.D., 242 Trumbull St., Hartford 3. Meetings bimonthly, second Thursday.

FLORIDA

Florida Radiological Society.—Secretary-Treasurer, Charles M. Gray, 306 Citizens Bldg., Tampa 2.

GEORGIA

Georgia Radiological Society.—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta 3. Meetings twice annually, in November and at the annual meeting of State Medical Association.

ILLINOIS

Chicago Roentgen Society.—Secretary, Warren W. Furey, M.D., 7144 Jeffery Ave., Chicago 49. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

Illinois Radiological Society.—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago 12.

INDIANA

The Indiana Roentgen Society.—Secretary-Treasurer, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis 7. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

KENTUCKY

Kentucky Radiological Society.—Secretary-Treasurer, Sydney E. Johnson, M.D., Louisville City Hospital, Louisville. Meeting annually in Louisville, third Saturday afternoon in April.

LOUISIANA

Louisiana Radiological Society.—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

Shreveport Radiological Club.—Secretary-Treasurer, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday, at the offices of the various members.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Secretary, Walter L. Kilby, M.D., 101 W. Read St., Baltimore 1. Meets third Tuesday of each month.

MICHIGAN

Detroit X-ray and Radium Society.—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit 1. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

Michigan Association of Roentgenologists.—Secretary-Treasurer, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

MINNESOTA

Minnesota Radiological Society.—Secretary, A. J. Stenstrom, M.D., Minneapolis General Hospital, Minneapolis 26. Meetings quarterly.

MISSOURI

Radiological Society of Greater Kansas City.—Secretary, Arthur B. Smith, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

The St. Louis Society of Radiologists.—Secretary, E. W. Spinzig, M.D., 2646 Potomac St. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

NEBRASKA

Nebraska Radiological Society.—Secretary, F. L. Simonds, M.D., 1216 Medical Arts Bldg., Omaha 2. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

NEW ENGLAND

New England Roentgen Ray Society (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—*Secretary,* Hugh F. Hare, M.D., Lahey Clinic, Boston 15, Mass. Meets monthly on third Friday at Boston Medical Library.

NEW JERSEY

Radiological Society of New Jersey.—Secretary, H. J. Perlberg, M.D., Trust Co. of New Jersey Bldg., Jersey City. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

NEW YORK

Associated Radiologists of New York, Inc.,—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

Brooklyn Roentgen Ray Society.—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave., Brooklyn 26. Meets fourth Tuesday of every month, October to April.

Buffalo Radiological Society.—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday evening each month. October to May, inclusive.

Central New York Roentgen Ray Society.—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse 10. Meetings are held in January, May, and October, as called by Executive Committee.

Long Island Radiological Society.—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—Secretary, Ramsay Spillman, M.D., 115 E. 61st St., New York 21, N. Y.

Rochester Roentgen-ray Society.—Secretary, S. C. Davidson, M.D., 277 Alexander St., Rochester 7. Meetings at convenience of committee.

NORTH CAROLINA

Radiological Society of North Carolina.—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

NORTH DAKOTA

North Dakota Radiological Society.—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

OHIO

Ohio Radiological Society.—Secretary, J. E. McCarthy, M.D., 707 Race St., Cincinnati 2. Next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

Cleveland Radiological Society.—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*Secretary-Treasurer,* Samuel Brown, M.D., 707 Race St., Cincinnati 2. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport 8. The Society meets annually.

The Philadelphia Roentgen Ray Society.—Secretary, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia 4. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

The Pittsburgh Roentgen Society.—Secretary-Treasurer, Reuben G. Alley, M.D., 4800 Friendship Ave., Pittsburgh 24, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

ROCKY MOUNTAIN STATES

Rocky Mountain Radiological Society (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—*Secretary,* A. M. Popma, M.D., 220 North First St., Boise, Idaho.

SOUTH CAROLINA

South Carolina X-ray Society.—Secretary-Treasurer, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16. Meeting in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—Secretary-Treasurer, Herman Klapproth M.D., Sherman.

VIRGINIA

Virginia Radiological Society.—Secretary, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond 19.

WASHINGTON

Washington State Radiological Society.—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

WISCONSIN

Milwaukee Roentgen Ray Society.—Secretary-Treasurer, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee 3. Meets monthly on second Monday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russell F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison 6, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

CANADA

La Société Canadienne-Française d'Electrologie et de Radiologie Médicales.—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

CUBA

Sociedad de Radiología y Fisioterapia de Cuba.—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

De Sanctis, A. G., Green, Martin, and Larkin, Vincent DeP. Porencephaly 604

Hamilton, Joseph G., et al. Radioactive Iodine Studies in Childhood Hypothyroidism ... 604

The Chest

Meneghello, Julio, and Smith, Clement A. Obstructive Emphysema and Atelectasis in Tuberculosis of Infants and Children 604

Salmon, G. W., and Forbes, G. B. Pneumothorax in the Newborn Infant 605

Lesser, Leonard I., Weens, H. Stephen, and McKey, John D. Pulmonary Manifestations Following Ingestion of Kerosene 605

Allen, E. V., and Baird, Lester, W. Pneumonia in the Army 606

Goldman, Alfred. Cavernous Hemangioma of the Lung: Secondary Polycythemia 606

Hartwell, Alfred S., and Tilden, Irvin L. Aneurysm of the Pulmonary Artery 606

Heimann, H. L., and Posel, M. M. Case of Congenital Dilatation of the Pulmonary Artery. 607

Epstein, Bernard S. Early Radiologic Recognition of Mitral Valve Disease 607

Scharer, R. F., and Pietrafesa, E. R. "Accordion Heart" Caused by Anemia ... 607

The Digestive Tract

Tidy, H. Peptic Ulcers and Dyspepsia in Army 607

Agerty, H. A., Ziserman, A. J., and Shollenberger, C. L. Case of Perforation of the Ileum in a Newborn Infant 608

Pasternack, J. G. Calcareous Pancreatitis 608

Stoll, Richard G. Pseudocysts of the Pancreas: Report of Three Cases 609

Bacon, Ralph D. The Fat Meal—Its Value in Cholecystography 609

The Skeletal System

Lurie, Louis A., Levy, Sol, and Lurie, Max L. Determination of Bone Age in Children. 609

Sontag, Lester W., and Lipford, Janet. Effect of Illness and Other Factors on the Appearance Pattern of Skeletal Epiphyses. 610

Robinow, M., Johnston, M., and Anderson, M. Feet of Normal Children. A Study of Lateral X-Rays of the Weight-Bearing Foot. 610

Love, J. Grafton, and Walsh, Maurice N. Protruded Intervertebral Disks 610

Nickerson, Samuel H. March Fracture or Insufficiency Fracture 611

Barns, H. H. Fouracre. March Fracture of the Metatarsal Bones 611

Blitz, Daniel. Infantile Scurvy. A Case Report with Follow-Up Roentgenogram of Pre-Existent Healed Scurvy 611

Gunther, Lewis, et al. Metabolism of Bone Salts in Resistant Rickets: Case, with Balance and Radioactive Tracer Studies ... 611

Moehlig, Robert C. Renal Dwarfism or Renal Rickets 612

Kraft, Ernest. Epidermoid Carcinoma of the Tibia: Report of Two Cases 612

Barden, Robert P. Similarity of Clinical and Roentgen Findings in Children with Ewing's Sarcoma (Endothelial Myeloma) and Sympathetic Neuroblastoma 612

Stein, Robert J. "Silent" Skeletal Metastases in Cancer 613

Robbins, Laurence L. Roentgenologic Demonstration of Spinal Metastases from Leiomyosarcoma of the Uterus 613

The Genito-Urinary Tract

Deming, Clyde L. Ureteropelvic Obstruction Due to Extrinsic and Intrinsic Lesions of the Ureter 613

The Vascular System

DeBakey, M. E., Schroeder, G. F., and Ochsner, A. Significance of Phlebography in Phlebothrombosis 614

RADIOTHERAPY

Quimby, Edith H., and Focht, Elizabeth F. Dosage Measurements in Contact Roentgen Therapy 614

Quastler, Henry. Depth Dose Measurements in Contact Roentgen Therapy on a Biological Test Object (Rabbit's Skin) 614

Charteris, A. A. Local Application of a Sulphanilamide Powder in Radiotherapy 615

Neoplasms

Yarnis, Harry, and Colp, Ralph. Lymphosarcoma of the Stomach 615

Weisel, Wilson, Dockerty, Malcolm B., and Priestley, James T. Wilms' Tumor. 615

Kirshbaum, Jack D., Larkin, Herbert S., and Culver, Harry. Retothel Sarcoma of the Prostate Gland 615

Smith, George G. Tumors of the Testicle: Fifty Cases Treated by X-Ray Therapy 616

Tamarkin, Saul J. X-Ray Therapy of Benign Uterine Bleeding and Fibromyoma 616

McGoldrick, J. L., and Lapp, Warren A. Leucemia and Pregnancy 617

Non-Neoplastic Disease

Oppenheimer, Albert. Roentgen Therapy of Interstitial Pneumonia 618

Mazer, Charles, and Greenberg, Rose. Low-Dosage Irradiation in the Treatment of Amenorrhea: An Additional 92 Cases 618

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Porencephaly. Adolph G. De Sanctis, Martin Green, and Vincent deP. Larkin. J. Pediat. **22:** 673–689, June 1943.

Porencephaly is a cystic defect of the brain communicating with the ventricles or separated from them by a thin layer of brain tissue and covered on the outside by the arachnoid. Five cases of this condition are reported.

The "complete" syndrome consists of two findings, hemiplegia and jacksonian convulsions, both involving the same side of the body. Mental deficiency frequently occurs, being present in 1 of this series, while 4 showed some developmental retardation. Less frequently hemianopsia, complete blindness, facial paralysis, and sensory disturbances are observed; they were not found in any of the cases here reported. Three of the patients gave a history of birth difficulties. Convulsions occurred in 4 cases. In 3 these were typical of the "complete" syndrome, *i.e.*, jacksonian in type and limited to the side showing paralysis; in 2 the convulsions and motor paralyses occurred simultaneously. One patient had no convulsions but the electroencephalogram was characteristic of epilepsy. Paralysis and weakness of the involved side, in the form of a spastic hemiplegia, were present in 4 patients. There were marked atrophy of the hemiplegic side and contracture deformities. In four patients the diagnosis of porencephaly was suspected before roentgen examination.

Encephalography is the most important procedure in confirming the diagnosis of porencephaly. In 3 patients in this series the condition was demonstrated by encephalographic studies. For the diagnosis by this means, the demonstration of a cyst or cysts of the brain, in most instances in communication with the lateral ventricles, is essential. Evidence of atrophy of the brain or arachnoiditis may or may not be present. Cystic degeneration of a glioma is the chief lesion which must be differentiated from a porencephalic cyst.

The criteria of diagnosis of porencephaly by ventriculography are the same as for encephalography. The ventriculogram has the advantage of the direct injection of air into the ventricular system and the consequent removal of some of the mechanical factors which might interfere with the rise of air in encephalography.

Electroencephalographic studies are of limited value, giving some indication of the location of the cyst and occasionally the tendency to convulsions.

The authors believe that surgical intervention in porencephaly will often result in motor improvement and relieve the convulsive phenomena partially or entirely. Medical treatment was feasible in only one of their patients; this child had convulsions which were completely controlled by sodium dilantin.

Radioactive Iodine Studies in Childhood Hypothyroidism. Joseph G. Hamilton, Mayo H. Soley, William A. Reilly, and Karl B. Eichorn. Am. J. Dis. Child. **66:** 495–502, November 1943.

By the addition of minute amounts of radioiodine, ordinary iodine can be "labeled" and its concentration in the thyroid can be determined quantitatively by a suitable detecting device, such as a Geiger-Müller counter. This procedure was followed in 10 children, aged 6 months to 19 years, having severe hypothyroidism. The labeled iodine was administered orally, each of the 8 older children receiving 14 mg. and each of the 2 younger children 3.5 mg. At the end of five days, only 3 children, including 2 with goiter, had accumulated 0.5 per cent or more of the labeled iodine; 2 had accumulated 0.1 per cent, and the remainder 0.05 per cent or less. In contrast, the thyroids of 5 normal adults showed an accumulation of 4 per cent and those of 3 normal children (4 to 10 years of age) of 2 per cent.

In the 2 children with goiter, the iodine uptake was surprisingly similar to that in hyperthyroidism, for the thyroids showed a maximum concentration four hours after ingestion as opposed to slow uptake in the other children. Further study is necessary in these 2 cases to determine if the iodine lost from their thyroids is in the form of active thyroid hormone, in which case normal thyroid function could be maintained with administration of sufficient iodine.

In a second experiment, six months later, 6 of the children, including the 2 with goiters, were given a small dose of radioiodine (orally) in the form of sodium iodide without carrier iodine, so that the total dose for each patient was approximately 0.1 microgram of labeled iodine. In the 4 patients without goiters the thyroids accumulated from 1.9 to 4.5 per cent of the iodine by the end of the fifth day, indicating that thyroid tissue will take up a greater proportion of a small dose than of a large dose of iodine. In the 2 children with both hypothyroidism and goiter, the uptake was 53 and 33 per cent, respectively. Radioautographs of microscopic sections from the thyroids in these 2 cases showed that most of the labeled iodine was deposited in the cells of the acini rather than in the colloid. Iodine fractionations done on the excised thyroid tissue showed that one-fifth of the iodine was in the form of thyroxine.

LESTER M. J. FREEDMAN, M.D.

THE CHEST

Obstructive Emphysema and Atelectasis in Tuberculosis of Infants and Children. Julio Meneghello and Clement A. Smith. J. Pediat. **22:** 265–285, March 1943.

The case histories of 15 infants and children in whom tuberculosis was the cause of mechanical obstruction of the bronchial passages are presented and discussed.

In most infants and children with tuberculosis the lymph node involvement is more extensive than the primary focus in the lungs, and in some cases the preponderance of lymph node infection may be extreme. The anatomic association of these nodes with the bronchi offers an obvious opportunity for mechanical interference with respiration. Either atelectasis or emphysema may result, depending upon the completeness with which the air passages are obstructed, and either condition may succeed the other in the same child.

Nine of the 15 children in this series were less than two years of age. Symptoms tended to be rather indefinite at the onset and were rather loosely described

by the parents as "heavy breathing," "noisy breathing," or "wheezing." In 9 patients the tuberculous process produced atelectasis of some portion of the lungs and in the other 6 an obstructive emphysema. The symptoms were only slightly different in the two groups. Physical signs depended somewhat on the extent of the lung involvement, the persistence of the process, and the number of opportunities for examination. Of the 9 children with atelectasis, 2 (infants) showed no significant physical findings; in the other 7 patients areas of dullness and diminished breath sounds were encountered over the involved region. Of the 6 children with primary emphysema, one (an infant) showed no physical signs except generalized rhonchi. The others tended to exhibit an increase of resonance with associated diminution of breath sounds which would mark the area of air-filled lung whose communication with the trachea had been partially cut off.

Roentgenograms of the 15 children were, in general, not puzzling. Usually there was no difficulty, particularly when fluoroscopy was used, in ascertaining an obvious disturbance of a major airway or in distinguishing between those cases marked by atelectasis and those with emphysema, although a certain amount of compensatory emphysema was, of course, usually present in lung tissue adjacent to the atelectatic area.

Bronchoscopy is recommended as a diagnostic procedure in these cases. In the authors' experience the use of lipiodol has yielded little, if any, additional information. Bronchoscopic examination was carried out in 9 patients. In one child no local abnormality was observed. Three cases showed narrowing or constriction of the bronchus, apparently due to pressure from without. In one patient there were both narrowing and granulation tissue in the bronchus. In 3 others granulation tissue, with more or less exudate beyond it, was present in the bronchi. In one case a foreign body was found embedded in tuberculous granulation tissue. No particular form of obstruction was associated with either characteristic type of disturbance in the associated lung or lobe.

Granulation tissue removed by biopsy in 2 of the cases was found to contain tubercle bacilli; in 2 other biopsies the tissue was consistent with that of tuberculosis, although the organism was not discovered. It is the impression of the authors that tuberculous tissue either arising in the wall of the bronchus or penetrating it by extension from an involved peribronchial lymph node is a slightly more common cause of obstruction than is the pressure effect of an external mass of nodes.

No specific mode of therapy is recommended, beyond the general hygienic care of the tuberculous child. Although collapse or emphysema may persist for six months or more, the ultimate outcome has been complete recovery in the large majority of these patients.

Pneumothorax in the Newborn Infant. Report of Three Cases. G. W. Salmon and G. B. Forbes. J. Pediat. **23:** 50–58, July 1943.

Three cases of pneumothorax in the newborn infant are presented.

In seeking the cause of an unexplained pneumothorax, two factors must be borne in mind: (1) a pathologic process of the respiratory tract and (2) overventilation or distention of the alveoli. Either or both of these may result in weakening of the walls of the respiratory tract and contribute to a break in their continuity at one or more points. Either one alone, if sufficiently marked, may lead to the appearance of air outside of the normal pathways.

In pneumothorax of the newborn infant due to congenital deformities of the respiratory system, to local trauma (such as fractured ribs), or to neonatal pulmonary infections, the pathologic process is the more important. In labored respiration with increased respiratory excursion secondary to obstruction due to tenacious secretions in the tracheobronchial tree (especially with a ball-valve mechanism and distal emphysema), atelectasis (especially with an area of compensatory emphysema), intracranial hemorrhage, and congenital heart disease, the factor of overdistention enters. This latter factor has been emphasized by Macklin (Arch. Int. Med. **64:** 913, 1939), whose experimental studies appear to establish a relationship of pulmonary interstitial and mediastinal emphysema to pneumothorax.

The diagnosis of pulmonary interstitial emphysema is difficult to make and requires radiographic confirmation. The outstanding symptoms of mediastinal emphysema—dyspnea and cyanosis—are caused by the mechanical effect of the abnormal presence of air on the great vessels, particularly the veins. The heart sounds are distant. In adults, a crackling, crunching sound synchronous with the heart beat may be present and precordial pain may be an outstanding complaint. The signs and symptoms leading to a diagnosis of pneumothorax need no special comment except that in those cases in which the factor of overventilation and distention is the more important, and which are presumably more likely to be preceded by mediastinal emphysema, the respiratory difficulty is the cause of the pneumothorax and not *vice versa*.

Final convincing proof of these cases rests on the radiographic findings. In many cases even an x-ray diagnosis of pulmonary interstitial emphysema is difficult. In most cases an x-ray diagnosis of pneumothorax is easy enough, nor should the x-ray diagnosis of uncomplicated mediastinal emphysema cause much trouble. An anteroposterior or postero-anterior view of the chest will show the air. A characteristic paracardiac halo of air has been described. A lateral view of the chest should be conclusive. However, should mediastinal emphysema be complicated by pneumothorax and, as the elastic lung collapses, a high percentage of the air in the mediastinum thus be removed, the anteroposterior or postero-anterior views might not be conclusive, and air in the pleural sac would interfere with the lateral view.

Pulmonary Manifestations Following Ingestion of Kerosene. Leonard I. Lesser, H. Stephen Weens, and John D. McKey. J. Pediat. **23:** 352–364, September 1943.

Thirty-three children, from one to three years of age, with kerosene poisoning were admitted to the Grady Hospital (Atlanta, Ga.) during a two-year period. The amount of kerosene taken ranged from one swallow to half a glassful; the interval before examination varied from thirty minutes to forty-eight hours.

Thirty of the 33 patients had temperatures ranging from 99 to 104.5° F.; in the average uncomplicated case the fever was of three days' duration. Vomiting

of non-projectile type occurred almost immediately after ingestion of kerosene in 16 children but did not persist longer than a few hours. Coughing occurred in 13 cases, appearing immediately after ingestion. Ten patients were drowsy on admission to the hospital; 2 were in a comatose condition. Clinical signs of pneumonia (fever in the presence of diminished or tubular breath sounds, diminished resonance, and râles) were present in 8 patients. Sixteen showed a leukocytosis. There were no fatalities in this group.

Roentgenograms of the chest were made in 22 cases. Seventeen of these patients showed pulmonary changes —fine or coarse mottled confluent or non-confluent densities and diffuse densities in the lung fields. The presence of a peribronchial reaction was not considered evidence of pulmonary involvement unless the above-described findings appeared on subsequent examination. The roentgen picture was not uniform. In mild cases a patchy consolidation in the cardiophrenic angles was observed. This was usually preceded by a peribronchial reaction at the corresponding site. In more severe cases a diffuse density extended from both hilar areas toward the periphery of both lung fields, this opaque consolidation resolving in the form of fine mottled densities. The pulmonary changes are seen early. Most of the patients examined showed definite changes four hours after the ingestion of kerosene; two patients showed changes after one and two hours.

The second section of the paper is an autopsy report of an 18-month-old child [not among the 33 patients previously discussed], who died approximately five hours after ingestion of about 150 c.c. of kerosene, with severe pulmonary edema. The lungs showed microscopic evidence of acute pneumonia.

The author concludes with an account of an experimental study carried out to determine whether the pulmonary manifestations of kerosene poisoning are due to the effect of aspiration or the result of irritation of the lungs following excretion of the kerosene absorbed from the gastro-intestinal tract. Varying quantities of kerosene were injected by stomach tube into each of a group of 6 rabbits, and the lungs were checked by x-ray examination before and at varying intervals after injection. In a second group of 6 rabbits quantities of kerosene varying from 0.75 to 2.0 c.c. were injected intratracheally by means of direct puncture of the trachea with a hypodermic needle. The lungs of these animals were examined roentgenologically at intervals of thirty minutes to three days after the experiment. None of the rabbits in the first group showed involvement of the lungs; all of the animals in the second group had pulmonary manifestations. According to this evidence, kerosene intoxication follows aspiration into the respiratory tract and not absorption from the gastro-intestinal tract.

This study indicates that pulmonary manifestations following kerosene ingestion are much more frequent than previously supposed. Physical findings in the chest are by no means adequate criteria for the diagnosis. Pulmonary changes were observed in 77 per cent of the patients examined roentgenologically, as compared with only 24.2 per cent by physical examination only.

Pneumonia in the Army. E. V. Allen and Lester W. Baird. New Orleans M. & S. J. **96:** 177–184, November 1943.

Pneumonia is classified by army medical authorities as follows: (1) primary pneumonia, caused directly by bacteria or a virus, (2) secondary pneumonia, occurring as a frequent complication in the course of another affection, such as measles, psittacosis, etc.

In the Seventh Service Command, from which the present report comes, pneumonia due to rare causes such as psittacosis, brucellosis, tularemia, and rickettsiosis had not been observed recently. One case of pneumonia due to coccidioidomycosis and several cases attributable to Friedländer's bacilli, staphylococci, and hemolytic streptococci were on record. A few questionable cases of true influenzal pneumonia, caused by the influenza virus B and characterized by an acute onset, generalized aching, severe headache, marked prostration, sore throat, and leukopenia, were observed. (This disease killed 19,249 of the armed forces in World War I.) The most common varieties of pneumonia encountered were primary pneumococcus pneumonia and primary atypical (virus) pneumonia, the latter constituting 50 to 80 per cent of all Army pneumonias.

No deaths from either pneumococcus or virus pneumonia were reported in the Seventh Service Command. Three deaths from pneumonia occurred among 1,488 patients in three large station hospitals and all were attributed to staphylococcic pneumonia.

The authors describe the general features of both pneumococcus and virus pneumonia and include some typical case records.

LESTER M. J. FREEDMAN, M.D.

Cavernous Hemangioma of the Lung: Secondary Polycythemia. Alfred Goldman. Dis. of Chest. **9:** 479–486, November–December 1943.

The author's patient, a 22-year-old man, had had a persistent shadow in the left lung since the age of 5. Slight cyanosis and clubbing of the fingers and toes were present from childhood. Since the age of 17 there had been signs and symptoms of polycythemia, with no response to radiation therapy, venesection, or radioactive phosphorus. Laminagrams showed the lung lesion to be a solid branching tumor-like mass, and this observation together with an oxygen arterial saturation of 70 per cent led to the diagnosis of a cavernous hemangioma acting as an arteriovenous fistula. Three similar cases of cavernous hemangioma of the lung producing polycythemia have been reported, one of which was verified at autopsy, and another following pneumonectomy (Rodes: J. A. M. A. **110:** 1914, 1938; Smith, H. L., and Horton: Am. Heart J. **18:** 589, 1939; Hepburn and Dauphinee: Am. J. M. Sc. **204:** 681, 1942). HENRY K. TAYLOR, M.D.

Aneurysm of the Pulmonary Artery: Report of a Case in Which the Aneurysm Apparently Developed Under Observation. Alfred S. Hartwell and Irvin L. Tilden. Am. Heart J. **26:** 692–698, November 1943.

The authors present the case history of a 12-year-old Filipino girl who had been under observation since the age of 6 because of cardiac enlargement and a family history of tuberculosis. A roentgenogram made in March 1942, four months before death, showed the enlargement of the heart. In July, hemoptysis having occurred, the patient was examined fluoroscopically. In addition to the cardiac enlargement previously observed there was now a marked prominence of the pulmonary conus area, suggesting a diagnosis of patent ductus arteriosus, while the clinical history presented evidence of a possible subacute bacterial

endocarditis. A roentgenographic study two days before death corroborated the fluoroscopic findings. Two blood cultures were positive for *Streptococcus viridans*.

Postmortem examination revealed a ruptured aneurysm (3.5 × 2.5 cm.) arising from the anterior wall of the pulmonary aorta, approximately 2 cm. above the pulmonary valve ring. Opposite the opening of the aneurysmal sac was a large patent ductus arteriosus which measured 1 cm. in diameter.

The authors believe that an infection, superimposed upon the congenital defect, may have played an important role in the production of the aneurysm.

HENRY K. TAYLOR, M.D.

Case of Congenital Dilatation of the Pulmonary Artery. H. L. Heimann and M. M. Posel. Brit. M. J. **2:** 512, Oct. 23, 1943.

The author calls attention to the rarity of congenital dilatation of the great vessels and the relative frequency of congenital septal defects. The conditions, however, have a certain association, as a septal defect commonly accompanies the arterial dilatation. Usually the auricle is grossly enlarged in addition.

A classification of cases is offered, the main headings of which are (*a*) acquired and (*b*) congenital. Notable in the acquired list is aneurysm of the pulmonary artery and stasis in the pulmonary circulation associated with pulmonary stenosis. Various congenital conditions are noted, the first and foremost being an asymmetrical division of the truncus arteriosus communis.

The criterion of radiological diagnosis of congenital dilatation of the pulmonary artery consists in an increased pulmonary bow, small aortic knuckle, broadened shadow, and pulmonary arterial tree enlargement.

An account of one case is given, in which the x-ray examination demonstrated a huge pulmonary artery and a large impression in the barium-filled esophagus, apparent in the right oblique position.

Q. B. CORAY, M.D.

Early Radiologic Recognition of Mitral Valve Disease. Bernard S. Epstein. J. Pediat. **23:** 381–390, October 1943.

In order to determine the roentgenologic procedure most helpful in diagnosing early rheumatic mitral valve changes, 25 selected children—11 boys and 14 girls between 3 1/2 and 15 years of age—were studied fluoroscopically and by means of teleroentgenograms and oblique views of the heart. The clinical diagnoses in these cases were mitral insufficiency, mitral stenosis, and insufficiency or functional heart murmurs. Sixteen of the group had a definite and 2 a doubtful history of rheumatic fever; 7 had no known rheumatic infection.

Electrocardiograms were available for 23 patients. No changes in axis deviation, P waves, or auriculoventricular conduction times were present except in 2 instances in which there was an increased P-R interval during acute exacerbations.

Teleroentgenograms revealed an apparently normal heart silhouette in 20 patients. In the other 5 doubt existed whether or not the prominence in the region of the second left cardiac arc was indicative of pulmonary artery or conus enlargement.

Routine fluoroscopic examination of the heart included inspection of the barium-filled esophagus. There was slight but definite posterior enlargement of the left auricle in all the patients, as shown by indentation of the esophagus in the right anterior oblique projection; the indentation was usually best portrayed at an angle from 55 to 80 degrees. This was determined fluoroscopically before the oblique roentgenograms were made. No change in the course of the esophagus was noted in the postero-anterior view. The left main bronchus was in its normal position in all patients. In none did the left auricle approach the right heart border. In 5 patients there was anterior prominence of the right ventricle, indicative of early outflow tract enlargement. No definite evidence of enlargement of the left ventricle or right auricle was seen.

This study shows fluoroscopy to be the best method of diagnosing early mitral disease. Other procedures for determining cardiac enlargement based on calculations made from teleroentgenograms and tables of the patients' heights and weights were found to be unreliable in detecting early left auricular enlargement. The frontal silhouette of the heart may retain a normal appearance even when the left auricle is considerably enlarged posteriorly.

An Original Observation: "Accordion Heart" Caused by Anemia. Rodolfo F. Scharer and Eugenio R. Pietrafesa. Radiologia **6:** 22–28, January–April 1943.

Scharer and Pietrafesa report what they believe is an original observation on changes in the size of the heart in anemic patients. They claim that the heart enlarges when the anemia is severe and is reduced in size with improvement of the blood picture. This observation was made in cases of pernicious anemia. The term "accordion heart" is suggested as descriptive of the phenomenon.

A. MAYORAL, M.D.

THE DIGESTIVE TRACT

Peptic Ulcers and Dyspepsia in the Army. Henry Tidy. Brit. M. J. **2:** 473–477, Oct. 16, 1943.

This article is a rather detailed discussion of the incidence of peptic ulcer in the army and its relation to a form of dyspepsia which occurs without apparent pathology.

There is a transient form of dyspepsia which is common in new recruits and should not require hospitalization. The latter, indeed, is likely to make a chronic dyspeptic of the patient by suggestion. Under the heading of gastritis and functional dyspepsia the author discusses another large group of cases, nearly all of which reveal little or no organic change. The name is rather vague and no satisfactory nomenclature has been evolved. Some patients in this class continue to complain for as long a period as seven years. In a small proportion of the cases organic gastritis is revealed by gastroscopy. "Duodenitis" is disposed of as a radiological concept without clinical, surgical, or pathological support. The general psychoneurotic phase of the subject is presented, and it is pointed out that functional dyspepsia is frequently more firmly established by the efforts of the doctor at diagnosis, well meaning though he may be. This type of dyspepsia has obviously increased greatly in civilian life, and statistics from army personnel show an incidence of 52 to 58 per cent of non-ulcer dyspepsia among gastrointestinal cases.

In discussing etiology it is brought out that standards of cooking and change in general environment are not sufficient to explain the increase in peptic ulcer. Over 80 per cent of the patients are found to have had symptoms in civilian life. In short, the main source of ulcer cases in the army is a recurrence of old symptoms. A like situation obtains in the case of non-ulcer dyspepsia. The incidence of the various types of ulcer is discussed and it is pointed out that relapses are much more likely to occur in the army than in civilian life.

Some interesting comments are made under the heading "Disposal of Ulcer Cases." Generally it has been found advisable to invalid from military service all patients with peptic ulcer. The number of these, however, is so great in this war that someone has suggested that special ulcer battalions be formed. This move has never been seriously considered for the reason that it would entail a complication of army routine that has never been attempted. It is interesting that the usual complications of peptic ulcer are comparatively rare in army life. The situation as regards the A.T.S. personnel is discussed. The ratio of incidence between male and female is usually four to one.

Q. B. CORAY, M.D.

Case of Perforation of the Ileum in a Newborn Infant with Operation and Recovery. H. A. Agerty, A. J. Ziserman, and C. L. Shollenberger. J. Pediat. **22:** 233–238, February 1943.

Perforations of the gastro-intestinal tract in fetal life and in the neonatal period are not common occurrences; usually cases have been diagnosed only at autopsy. A frequent cause is a cystic fibrosis of the pancreas, which alters the character of the meconium, producing a meconium plug or inspissation, which in turn gives rise to intestinal obstruction and perforation.

A case of perforation of the ileum in a newborn infant is reported. The clinical picture was typical of intestinal perforation—abdominal distention, grunting respirations, absence of peristalsis, poor color, and edema. A roentgenogram substantiated the diagnosis, a flat plate of the abdomen showing marked evidence of pneumoperitoneum, with gas under both sides of the diaphragm above the liver and spleen. Dilated coils of small intestine were seen, and a transverse loop which was thought possibly to be the transverse colon. At operation (56 hours after birth) a perforation of the ileum was found; this was closed. Thirty-six hours later, peristalsis was first heard. A short time after this the first stool, consisting of a dark plug of meconium followed by a large amount of normal meconium, was passed. The cause of the perforation in this case is not certain; the meconium plug could have formed an obstruction. There was nothing to suggest a cystic fibrosis of the pancreas or an obstruction of the biliary tract. This is the first example to be reported of recovery following a perforation of the gastro-intestinal tract in a newborn infant.

Calcareous Pancreatitis: Report of Three Cases with Autopsies. Joseph G. Pasternack. Ann. Int. Med. **19:** 757–767, November 1943.

Three cases of advanced calcareous pancreatitis discovered at autopsy are reported and the general features of the condition are discussed. The cause of stones in the ducts and calcareous changes in the parenchyma of the pancreas is not definitely known. Infection by way of the ducts, regurgitation from the biliary tract, and stasis of pancreatic secretion are probably important contributing causes. Etiologic significance is also attributed to alcoholism, since the condition has been recorded in chronic alcoholics. In a few cases, cirrhosis of the liver and fatty metamorphosis have been present.

A study by Edmondson and Fields (Arch. Int. Med. **69:** 177, 1942) of acute pancreatic necrosis is suggestive in connection with the pathogenesis of chronic calcareous pancreatitis. In the former condition the fat necrosis has been shown to be due to the splitting of neutral fat into fatty acids and glycerin by the action of lipase that has escaped into the tissues from the pancreatic juice. The glycerin is absorbed and the fatty acids combine with calcium to form insoluble soaps. These authors demonstrated large quantities of calcium in acute pancreatic lesions, and they found a moderate fall in the serum calcium of patients with acute pancreatic necrosis, between the third and the eleventh day of the disease. Patients with pancreatolithiasis frequently give a history of obscure attacks of abdominal pain and of episodes of vague gastro-intestinal disturbances of variable severity. These may well represent subclinical or abortive attacks of acute pancreatic necrosis. Once formed, a focus of calcification continues to grow by the further addition of calcium salts.

The time required for stones in the ducts to form or for calcareous pancreatitis to develop is indefinite and highly variable. In one of the author's cases roentgenograms made two and one half years before the discovery of advanced pancreatolithiasis at autopsy showed no evidence of calculi.

The concretions may be in the form of sand or gravel, and calculi as large as walnuts have been reported. Usually duct stones are multiple. They are of a grayish or brownish-gray color, hard, rough and angular, often sharp. They may be stag-horn or branched like coral. Sometimes they are facetted. The larger stones are usually found in the head near the duodenal orifice of the pancreatic ducts, but they may be in any part of the gland. The ducts are dilated, elongated, and deformed, and atrophy and progressive fibrosis are observed with more or less destruction of the parenchyma of the gland.

As a result of obstruction of the ducts or destruction of the acinar tissue, disturbances due to a deficiency of the pancreatic enzymes in the intestine may be conspicuous. Diabetes, present in all of the author's patients, is due to destruction of the islands of Langerhans.

Clinical manifestations of calcareous pancreatitis are usually vague, and without roentgenograms the diagnosis cannot be established. Pancreatic colic is usually in no way distinguishable from biliary colic, though it may be associated with left-sided extension and projection of the pain into the left costovertebral angle. Signs and symptoms of pancreatic insufficiency are present in about half of the cases. Frequent bulky pale stools, marked inanition, and extreme asthenia are the most characteristic clinical manifestations.

Pancreatic stones are usually sufficiently opaque to cast a shadow. They are best demonstrated in an oblique roentgenogram. The diagnosis is further established by demonstration of (*a*) an absence or deficiency of pancreatic enzyme in duodenal drainage, and (*b*) an excess of both fat and nitrogen in the stool.

Oral pancreatic enzyme therapy is effective when the symptoms are those of pancreatic achylia. Cases not too advanced are amenable to surgical treatment.

STEPHEN N. TAGER, M.D.

Pseudocysts of the Pancreas: Report of Three Cases. Richard G. Stoll. Ohio State M. J. **39:** 1014–1016, November 1943.

Pseudocyst of the pancreas has been variously defined. According to Mahorner and Mattson (Arch. Surg. **22:** 1018, 1931), it is a cystic area, either extraparenchymal or interparenchymal, having no epithelial lining. Among the causative factors mentioned are trauma, degenerative changes following fat necrosis, hemorrhage, and the action of released pancreatic enzymes. Actually, it is difficult to differentiate between pseudocyst and a true dilatation of the pancreatic ducts grossly or microscopically, inasmuch as true cysts sometimes lose their epithelial lining.

Pseudocysts may arise from any portion of the gland, occurring slightly more often in the tail. They may be attached by a broad or narrow pedicle and may present through the gastrocolic or gastrohepatic ligament or may invaginate between the layers of the transverse mesocolon behind the transverse colon.

Local pain, an epigastric mass, and weight loss are the most common symptoms. Nausea and vomiting, as well as jaundice, may occur if the cyst becomes very large. A smooth immobile mass between the ensiform and the umbilicus in the mid-line or in the left upper quadrant, not attached to the abdominal wall, is typical. The mass may be movable if in the tail of the pancreas or if it has a narrow pedicle.

X-ray examination is one of the best diagnostic aids. Depending on its position, the cyst produces pressure defects or displacement of the stomach, duodenum, small and large bowel.

Total excision is recommended if the cyst is small or in the tail of the pancreas. Larger lesions are marsupialized with direct external drainage. Radium has been employed to hasten closure of the fistulous tract (Hamilton: Surg., Gynec. & Obst. **35:** 655, 1922).

Three interesting case histories are presented. A roentgen illustration from each case is included showing well defined pressure defects and displacement of the stomach, small bowel, and transverse colon.

LESTER M. J. FREEDMAN, M.D.

The Fat Meal—Its Value in Cholecystography. Ralph D. Bacon. Pennsylvania M. J. **47:** 137–143, November 1943.

The visualized gallbladder proves the location of calcific stones and provides a contrasting background for non-calcific stones. Good visualization generally means a normal gallbladder and non-visualization usually indicates biliary tract disease. A poor shadow presents a problem in interpretation, since it may be indicative of either gallbladder disease or disease outside the biliary tract. The author believes that a study of the emptying of the gallbladder after a fat meal may be of significance in these cases.

A group of 429 cases is reviewed, the findings being as follows:

Normally functioning.....135 (31%)
(dense shadow 50% in size after fat meal)

Abnormally functioning.....175 (41%)
(no shadow)

Partially functioning.....119 (28%)
Calculous.....54
Non-calculous.....65 (15% of total series)
Poor concentration..95
Poor evacuation....53
Poor evacuation as single finding.....21 (5% of total series)

The examination was made by the usual double-dose method, with the first exposure fourteen hours after the second dose of sodium tetraiodophenolphthalein and another exposure four hours later if necessary. A fat meal was then given, consisting of two raw eggs in eight ounces of milk and cream (half and half) taken with buttered toast and any other food desired. One hour later an evacuation film was taken. If this showed a reduction of 50 per cent in the size of the gallbladder, no further films were taken. If the emptying time was less than 50 per cent, films were taken each hour for three hours or until a 50 per cent reduction in size was obtained. If this could not be accomplished within the three-hour period, the gallbladder was under suspicion as a poorly functioning organ.

A questionnaire sent to a group of radiologists shows that, although nearly all believe the emptying time is of importance, their evaluation of it varies widely. In the author's series 12 patients with delayed emptying came to operation. Eleven of these showed disease of the gallbladder wall. On the basis of his group of cases and from replies to the questionnaire mentioned above, the author believes that "the available evidence indicates that the finding of poor contractility warrants a conclusion of abnormal biliary tract function."

JOSEPH T. DANZER, M.D.

THE SKELETAL SYSTEM

Determination of Bone Age in Children. A Method Based on a Study of 1,129 White Children. Louis A. Lurie, Sol Levy, and Max L. Lurie. J. Pediat. **23:** 131–140, August 1943.

The authors present a method for determining the skeletal age, based on a study of 1,129 white children (704 boys, 425 girls). The ages of the children ranged from 2 1/2 to 19 years. Roentgenograms of more than 2,100 children were examined, but those of children suffering from endocrine disorders or from severe nutritional disturbances were not included in this study.

The variations in the state of osseous development were based on one-year age differences. Each child's roentgenograms were read from the standpoint of the time of appearance of the various epiphyses as well as the time of their fusion. Since girls show an accelerated bone maturation, separate charts were made for boys and girls.

To make this procedure as simple and inexpensive as possible, without sacrificing accuracy, only four roentgenograms were used: (1) the hand, including the wrist, (2) the elbow, (3) the pelvis, and (4) the foot, including the ankle. The authors point out that the lesser trochanter of the femur should be disregarded as a bone age determinator because of the likelihood of distortions due to variations in the focusing on this part.

Seventeen charts representing the range of time of the appearance and fusion of the epiphyses are repro-

duced. Two graphs furnish a quick and simple method of determining the bone age in boys and girls, respectively. By comparing the bone of the child with his chronological age, the bone quotient can be easily computed. This provides a uniform method of presenting deviations from the norm in the rate of bone development.

Effect of Illness and Other Factors on the Appearance Pattern of Skeletal Epiphyses. Lester Warren Sontag and Janet Lipford. J. Pediat. **23:** 391–409, October 1943.

The time of appearance of each of thirty-eight selected ossification centers was determined from serial x-rays of the left side of the body, in 84 children. Some children's centers presented a pattern rather consistent with the group pattern, while others deviated greatly from it. Faster growing children had fewer "out-of-line centers" than did slow-growing ones. Incidence of the usual childhood diseases was greater among the fast-growing than among the slow-growing children. Occurrence of such illness in this series did not delay the centers which were about to appear at the time of illness nor cause a greater incidence of centers "out of line" with the group or the child's own pattern. There was a greater likeness in ossification patterns among siblings than among non-siblings and among like-sexed siblings as compared with siblings not of the same sex. Monozygotic twins showed even more clearly the genetic factor in ossification pattern. This work corroborates the observations of others on the significance of the genetic factor in ossification pattern but does not imply that it is the only consideration of importance. The differences in the patterns of monozygotic twins, while less than between siblings, indicate definitely that other factors play a role.

The paper is accompanied by numerous diagrams and tables and should be consulted in the original by those interested in this subject.

Feet of Normal Children. A Study of Lateral X-Rays of the Weight-Bearing Foot. Meinhard Robinow, Margaret Johnston, and Margaret Anderson. J. Pediat. **23:** 141–149, August 1943.

A study of the arches of normal children by means of lateral roentgenograms is presented. From one to nine roentgenograms were made for each child. The ages of the children ranged from 2 1/2 to 13 years. Over 800 roentgenograms were studied.

A standard x-ray technic was carefully maintained. The child stood with his weight distributed equally on both feet. The target-film distance was 36 inches (91.5 cm.). The central ray was directed at the external malleolus. The cassette was placed between the feet, close to the left foot but not in contact with it. The examinations were made at intervals of six months.

The films were analyzed according to the method described by Bertani and Moreau, measurements being made of the four angles defined by the following landmarks: (1) the lowest point of the head of the talus, (2) the lowest point of the calcaneus, (3) the lowest point of the head of the first metatarsal, (4) the lowest point of the base of the first metatarsal, (5) the lowest point of the calcaneus at the calcaneocuboid articulation, (6) the lowest point of the head of the fifth metatarsal. Two angles measure the height of the medial and lateral aspects, respectively, of the longitudinal arch, another the anterior medial part of the arch, and the fourth the inclination of the calcaneus with the horizontal. Slightly different landmarks were used in the younger children because the contours of ossification centers differ somewhat from the final shape of the bones.

Measurements on x-ray films taken one year apart were correlated. High positive correlation coefficients indicate not only that the angles of individual feet are remarkably constant, but also that no major errors are introduced by variations of landmarks, inconsistency of roentgen technic, measurements, etc.

From this study the authors conclude that: (1) Frequency distributions of the angles closely resemble normal curves. (2) Most children's arches show very little change with age. (3) Low arches appear to be correlated with weight-length ratio at older ages studied. Correlations of questionable significance were obtained between foot angles and pronation, knock-knees, some other postural variables, and with age of starting to walk. (4) Correlation between siblings strongly suggests that a genetic factor is involved in determining the height of the arch.

Protruded Intervertebral Disks. J. Grafton Love and Maurice N. Walsh. Surg., Gynec. & Obst. **77:** 497–509, November 1943.

By protrusion of a disk the authors mean an abnormal posterior displacement of a portion of the disk. This is of significance only when there is associated fragmentation of the fibrocartilage causing stretching or tearing of the posterior longitudinal ligament on the anterior wall of the spinal canal, usually with associated "root irritation."

Protrusion of a disk is definitely due to trauma, often in connection with heavy lifting. The symptoms may be sudden or gradual in onset. The history should include the type of work done by the patient and also his hobbies, relation of pain (the cardinal symptom) to trauma and lifting, presence of previous backaches, type and constancy of pain, effect of coughing and straining at stool, results of various treatments, any listing of the trunk, particularly alternating listing, the presence or absence of paresthesias in the distribution of the pain, any disturbance of sleep by pain, and possible loss of weight. The presence of other diseases should be noted and considered. Anteroposterior, lateral, and occasionally oblique roentgenograms should be taken. Tuberculosis and neoplasms are to be excluded, and a competent orthopedic examination is essential.

Disk protrusions are mainly lumbar. Those in the cervical and thoracic regions simulate intraspinal neoplasm and, unless there is a history of trauma and intermittent symptoms, differentiation may be impossible without operation. Lumbar puncture should be performed to determine the presence or absence of a subarachnoid block and the total protein. Block is rare unless there is paraplegia, and the total protein is usually below 80 mg.; in one third of the cases it is below 40 mg. per 100 c.c. spinal fluid. Approximately 13 per cent of 5,500 patients with backache treated at the Mayo Clinic had protruded disks. By far the majority of these were in the 4th and 5th lumbar interspaces.

The classic picture of a lumbar protrusion includes pain, a list on walking and loss of lumbar lordosis with spasm of the erector spinae muscles and limitation of

spinal movements. A list may be evident only on forward bending with the knees straight. There is tenderness over the lower lumbar spine. Straight leg raising is painful and limited on the side of the sciatic pain or on both sides. Kernig's sign is positive. Bending the head forward on the chest aggravates the pain. Sciatic nerve tenderness may be extreme (palpation should exclude a primary nerve tumor). The Achilles reflex is usually diminished or absent. Extensive sensory loss is rare.

The authors feel that their clinical diagnosis is just as accurate as roentgenoscopic diagnosis obtained with radiopaque oil and more accurate than that obtained with air, which they now use almost routinely prior to operation. Because of slow absorbability and possible medicolegal complications, they have abandoned the use of radiopaque oil in disk cases. Air studies are important in excluding unsuspected neoplasm and multiple lesions but are practically valueless in thoracic and cervical lesions. The technic of lumbar puncture and spinography (air myelography) is described in detail. The use of a contrast medium, air or oil, should be delayed until operative plans have been made, since exacerbation of symptoms, headache, pain between the shoulders and around the chest, and nausea and vomiting commonly occur following their use.

The operation is described completely. The subperiosteal muscle reflection is usually unilateral and the ligamentum flavum is resected. Beneath this, the nerve root and blood vessels are retracted, revealing the protruded disk or bulging posterior longitudinal ligament. In the majority of cases the disk can be removed without opening dura or sacrificing bone. Drainage of the wound is usually unnecessary. Postoperatively the patients are advised to avoid the supine position, they are mobilized from the 5th to the 7th day and sutures are removed on the 9th or 10th day. Three months' convalescence is advised. Spinal fusion is not done in simple disk cases.

The authors' mortality rate has been 0.25 per cent. Complete relief of symptoms should be obtained in 80 per cent. The incidence of recurrence of lumbar protrusions is 2 per cent. Mild and borderline cases are given conservative orthopedic care and physical therapy. C. R. PERRYMAN, M.D.

March Fracture or Insufficiency Fracture. Samuel H. Nickerson. Am. J. Surg. **62:** 154–164, November 1943.

The cause of "march fracture," whether of the metatarsals or other bones, is discussed, and 2 cases involving the pubic bone are presented. [These were previously reported by Jones in RADIOLOGY **41:** 586, 1943.]

Twelve cases of fracture of the metatarsal are tabulated and the x-ray findings summarized as follows: (1) The earliest x-ray evidence is a fuzzy periosteal reaction along the medial side of the shaft. (2) The next finding is a break through the lateral cortical thickness. This break is at first incomplete, so that it does not extend across the entire cortical thickness. (3) There is more advanced periosteal reaction on the medial side. The outer layers of the lateral cortex have parted in a manner to suggest that they have "burst" in that direction. Others show changes which indicate that, in addition to this, there has been some minute internal collapse so that slight over-riding occurs. Probably included in this group are the films which show small chips "shelved off" the proximal cortex by this sliding by of fragments. (4) Stages of condensation of the periosteal proliferation with maturation into normal callus obscuring all the finer roentgenographic details.

The author suggests the term "insufficiency fracture" for this lesion, as it is essentially one of local inadequacy of metabolism, causing skeletal changes which render the bone more pliable and therefore more prone to fracture.

March Fracture of the Metatarsal Bones. H. H. Fouracre Barns. Brit. M. J. **2:** 608–609, Nov. 13, 1943.

According to the author of this article, the march fracture has again become of importance on account of intensive training during the war. As described elsewhere, it consists in the main of a fracture of a metatarsal bone which is not directly related to trauma. The onset of symptoms is outlined by the author and appropriate treatment suggested. March fractures are usually first seen several days after the initial separation of the bone has occurred, and diagnosis is made by x-ray. The lesion is first apparent on the dorsomedial aspect of the shaft of the bone, where new bone formation soon becomes demonstrable in the film.

Q. B. CORAY, M.D.

Infantile Scurvy. A Case Report with Follow-Up Roentgenogram of Pre-Existent Healed Scurvy. Daniel Blitz. J. Pediat. **23:** 87–89, July 1943.

A case with the classical symptoms and typical roentgenographic evidence of acute infantile scurvy is presented. A follow-up roentgenogram, four and one-half years after clinical cure, showed characteristic findings—oval, definitely circumscribed areas of rarefaction in the interior of the epiphyseal centers of ossification. The author calls attention to the fact that in the postwar period radiographic studies of children living in countries where food restrictions prevailed may be confusing if these signs are not recognized and considered.

Metabolism of Bone Salts in Resistant Rickets: Report of Case, with Balance and Radioactive Tracer Studies. Lewis Gunther, Elma T. Cohn, Waldo E. Cohn, and David M. Greenberg. Am. J. Dis. Child. **66:** 517–527, November 1943.

The author's patient, whose history is given in full, was a boy with resistant rickets from birth to the age of 14 years. Despite early institution of treatment by cod-liver oil, ultraviolet irradiation, and calcium supplements, severe genu varum was present at the age of two years. Repeated roentgenograms—reproduced in the paper—showed cycles of healing and active rickets during the course of the disease. Laboratory examinations showed no evidence of renal rickets or hyperparathyroidism. In 1939, when the boy was 13, treatment with massive doses of vitamin D was instituted, beginning with 122,000 U.S.P. units and subsequently reduced to 50,000 U.S.P. units daily. The immediate response was good, and roentgen studies in 1941 showed healing and recalcification of the bones.

Studies of mineral metabolism made in this case showed that a positive calcium and phosphorus balance

could be maintained only when the intake of these elements was high. Otherwise both the calcium and phosphorus balances were negative. The changes in the balances corresponded to changes in the amounts of the minerals excreted in the feces. The urinary excretion of both calcium and phosphorus remained practically unchanged with either high- or low-calcium diets.

Radioactive phosphorus (P^{32}) prepared in the cyclotron at the University of California was converted into soluble disodium acid phosphate and used in tracer studies. The labeled samples contained only a few milligrams of phosphorus, with radioactivity of about 30 microcuries. The material was given orally and a Lauritsen electroscope was used to determine the amount of excreted phosphorus after specimens of urine and feces were reduced to ash. Since the experiments showed that phosphates could be readily absorbed from the intestinal tract, the hypothesis is offered that the primary defect in resistant rickets is not failure of absorption of the bone salts but rather a failure of the calcifying mechanism.

LESTER M. J. FREEDMAN, M.D.

Renal Dwarfism or Renal Rickets. Robert C. Moehlig. Am. J. Roentgenol. **50:** 582–601, November 1943.

The outstanding features of the case here reported—in a boy aged five and a half years—were: dwarfism associated with an osseous disturbance, commonly called renal dwarfism or rickets; disturbance in kidney function with albuminuria; diabetes insipidus; progressive genu valgum, and sexual infantilism.

A comprehensive review is given of the work of many investigators of this disease. Throughout the reports in the literature it is noted that developmental defects of the kidneys and urinary tract are important features. The author gives evidence to show that the pituitary gland is responsible for the defects of the genito-urinary tract in that malformation or malfunction of the former causes malformation of the latter. Experimentally it has been shown by P. E. Smith (J. A. M. A. **88:** 158–161, 1927) and others that hypophysectomy results in atrophy of the suprarenal cortex and there also results an atrophy of the kidneys. Kidney malformations, agenesis, dilatation of the urinary tract, are all associated with pituitary anomaly. In the case reported, extensive hydrocephalus was present and there was damage to the pituitary as shown in roentgenograms of the skull as well as the definite clinical picture associated with hypofunction of the whole gland. That a hereditary element was present in this case seems likely. A duoparental pituitary disturbance was apparently passed on to the child. The high arched palate of the patient was taken as an indication that the development of the anterior lobe of the pituitary gland was disturbed, since this lobe develops from the roof of the mouth. The role of thyroid and testosterone propionate therapy in producing improvement for a limited time in this case is difficult to evaluate, since both were given at the same time. Posterior pituitary lobe extract in the form of pitressin tannate reduced the intake and output of fluids by approximately half. The patient died at the age of seven and one-half years with signs and symptoms of uremia. No autopsy was obtained.

A bibliography of 87 references is appended.

CLARENCE E. WEAVER, M.D.

Epidermoid Carcinoma of the Tibia: Report of Two Cases. Ernest Kraft. Am. J. Roentgenol. **50:** 602–608, November 1943.

There are two types, etiologically, of invasion carcinoma of the tibia: (1) ulcer carcinoma, which arises within a chronic ulcer of the leg, and (2) fistula carcinoma, which originates in a fistulous tract or osseous sinus. These two predisposing conditions may persist for years without malignant change. The tumors, even in an advanced stage, are characterized by a low grade of malignancy and hardly ever form distant metastases. Roentgenologically ulcer carcinoma is characterized by a scooped-out appearance of the bone, later by extensive osteolysis, and finally by pathological fracture. Osteomyelitic changes are absent but periosteal elevation may be noted proximal to the lesion. Roentgen diagnosis of fistula carcinoma is more difficult and is sometimes impossible when the lesion originates in a deep-seated osseous sinus. Chronic osteomyelitis tends to mask a malignant change in the beginning, but later in the disease there are decalcification, rapidly progressing rarefaction and surface erosion of bone, and finally a pathological fracture.

A fatal outcome is usually the result of surgical shock, secondary anemia, kidney and liver damage, and septicemia. It is rarely due to metastatic lesions. Since the disease tends to progress rapidly, amputation and even regional lymphadenectomy are necessary in most cases. The operative mortality has been greatly reduced by refrigeration anesthesia. Preoperative irradiation is contraindicated because of the danger of sarcomatous change.

Of the two cases reported, one was in a colored female, aged 66, who had suffered from varicose veins for more than thirty years. A recurrent ulcer of the left leg had been treated by "paste" and had spread rapidly. Roentgen examination revealed an extensive osteolytic process in the mid-shaft of the tibia with pathological fracture and periosteal thickening of the proximal one-third. Pathological examination showed a chronic ulcer of the skin eroding into the bone. The base of the ulcer contained nests of malignant epithelial cells with pearl formation.

The second patient was a white female aged 76, with a fistula carcinoma of the tibia arising from a chronic osteomyelitis which had been untreated for nine years. Pathological examination of the amputated leg disclosed the origin of the cancer to be within the fistulous tracts of the bone. The edges of the cutaneous ulceration were not malignant.

CLARENCE E. WEAVER, M.D.

Similarity of Clinical and Roentgen Findings in Children with Ewing's Sarcoma (Endothelial Myeloma) and Sympathetic Neuroblastoma. Robert Phelps Barden. Am. J. Roentgenol. **50:** 575–581, November 1943.

The histories of 4 children with roentgen evidence of widespread bone tumors are given. While 2 of these patients died of Ewing's sarcoma and 2 of sympathetic neuroblastoma, the clinical and roentgen findings in all were so similar as to make a differential diagnosis impossible before death.

A 5-year-old boy first presented the picture of aleukemic leukemia with roentgen evidence of widespread destruction of bone. The subsequent findings indicated that the leukemoid blood picture was due to overwhelming invasion of bone marrow by tumor

other than leukemia. Because of the extent of the bone involvement and the subperiosteal and diaphyseal location of the changes seen on the roentgenogram, the revised clinical diagnosis was neuroblastoma. Necropsy showed no possible primary neuroblastoma, and confirmed the biopsy report of Ewing's sarcoma.

A 2-year-old girl had extensive involvement of the skeleton which simulated closely the findings in the previous case. The pathological diagnosis, however, was adrenal neuroblastoma. Orbital metastases, which are of common occurrence with adrenal neuroblastoma, were present, but these may occur also in Ewing's sarcoma.

Each of the two other children had a large retroperitoneal mass with kidney displacement and areas of destruction in the skull, pelvis, and femora. In one of these cases several pathologists agreed on the diagnosis of Ewing's sarcoma. In the other case the pathologic report was sympathetic neuroblastoma.

On account of the difficulty in differentiating these two tumors, it is suggested that cases of solitary bone tumors diagnosed as Ewing's sarcoma should be treated as if the bone tumor were secondary to an abdominal tumor whether or not the presence of the latter can be established. This means that amputation for cure should probably not be attempted, and that roentgen irradiation to the retroperitoneal structures should be routine. CLARENCE E. WEAVER, M.D.

"Silent" Skeletal Metastases in Cancer. Robert J. Stein. Am. J. Clin. Path. **13:** 34–41, January 1943.

Obscure skeletal pain occurs frequently in cancer irrespective of the site of the primary growth, histologic nature of the malignant neoplasm, or its disseminative potentialities. In many such cases no roentgen evidence of secondary deposits can be found. Seventy-eight histologically proved cancer cases coming to autopsy were investigated (*a*) to determine whether or not metastatic tumor cells were present in the skeleton of cancer patients who complained of "bone pain" even though roentgenographically and grossly at autopsy there was no evidence of metastatic foci; (*b*) to determine if metastatic tumor cells were present in bone even though the patient was clinically symptom-free in so far as skeletal disease was concerned. The cases chosen were those which had been roentgenographically examined and showed no metastatic bone involvement. Of the 78 patients, 14 (18 per cent) had complained of "bone pain."

Microscopic metastatic deposits were found in the skeleton in 14 (60 per cent) of 23 patients with breast cancer, 7 of whom had complained of bone pain; in 11 (68 per cent) of 16 patients with carcinomas of the prostate, 3 of whom had bone pain; in 5 (25 per cent) of 20 patients with carcinoma of the cervix, of whom 2 had bone pain; in 1 of 6 patients with gastric carcinoma. No bone metastases were found in the cases of carcinoma of the rectum, urinary bladder, chorio-carcinoma of the testis, and melanoma of the skin. In most instances the metastatic growths were multiple.

From this study it is evident that skeletal metastases occur more often than commonly believed and in many instances can be detected only by complete examination of the skeleton at autopsy. In the great majority of cases the presence of one metastatic growth in bone must be taken to denote the almost certain presence of similar growths in other bones. Pressure on the adjacent nerves and erosion of the bone with the periosteum, which cause the pain in metastatic cancer, do not always occur, in which case the patient is symptom-free clinically.

Roentgenologic Demonstration of Spinal Metastases from Leiomyosarcoma of the Uterus. Laurence L. Robbins. Arch. Surg. **47:** 462–467, November 1943.

Two cases are reported in which vertebral metastases from leiomyosarcoma of the uterus were demonstrated roentgenologically. Histologic proof of both diagnoses was secured, in one case at necropsy and in the other at operation. In the roentgenograms of the second case, which are of excellent quality, being made with a rotating anode tube, osteoblastic densities surround irregularly placed linear areas of rarefaction which suggest vascular channels. In the first case the roentgenograms were not taken with a rotating anode tube and are less perfect technically; however, a suggestion of a similar distribution is seen. As this peculiar configuration has not been previously described, it is possible that it may be characteristic. Both cases showed metastases of purely osteoblastic type.

LEWIS G. JACOBS, M.D.

THE GENITO-URINARY TRACT

Ureteropelvic Obstruction Due to Extrinsic and Intrinsic Lesions of the Ureter as a Clinical Entity and Its Treatment. Clyde L. Deming. J. Urol. **50:** 420–431, October 1943.

The causes of extrinsic obstruction at the ureteropelvic junction are a thickening of the musculature, the development of hyperplastic fibrous tissue, and a fibrous contracture producing a small stoma, while intrinsic obstruction is due to strands of fibrous tissue running across the ureter at the junction and aberrant vessels.

In 16 of the 82 cases reported the condition was bilateral and in 35 the kidneys were infected. In some cases both fibrous tissue bands and aberrant vessels were present, and it was not clear which was the primary factor. Congenital lesions seemed to be more common in the early decades.

Nearly all types of plastic procedure were tried and in only 2 instances were they unsuccessful. The methods employed were (1) nephrectomy, (2) plastic procedures on the kidney pelvis, (3) plastic procedures on the ureter, (4) combined plastic procedures on the pelvis and ureter, (5) nephropexy. In 48 per cent of the cases nephrectomy was done because the kidney was nonfunctioning, indicating in general a long period of obstruction. This procedure was followed most frequently in the first and in the later decades of life. Nephropexy was commonest in the teen-age group, and was frequently done in conjunction with plastic procedures. The kidney was attached to the posterior abdominal wall, since attachment anteriorly causes movement on respiration, with subsequent ureteral kinking. Of the plastic procedures, the Rammstedt operation was particularly effective.

Urinary antiseptics were used in all cases, both therapeutically and prophylactically. Drainage, employed on infected kidneys only, was carried out by inserting a 12–14-F gallbladder T-tube into the ureter through a small longitudinal incision 4 cm. below the field of plastic repair. The lower arm extends 1 cm. downward and the upper arm well up into the renal pelvis, thus

affording an opportunity to irrigate the pelvis. Splints are unnecessary and may even be harmful, since they may introduce infection. DAVID KIRSH, M.D.

THE VASCULAR SYSTEM

Significance of Phlebography in Phlebothrombosis. M. E. DeBakey, G. F. Schroeder, and A. Ochsner. J. A. M. A. **123:** 738–744, Nov. 20, 1943.

In an article amply illustrated by roentgenograms and shaded line drawings, the authors present their experience with phlebography in the diagnosis of phlebothrombosis and thrombophlebitis of the lower extremities. Whereas in thrombophlebitis the thrombus is intimately attached to the vein wall and, therefore, seldom causes pulmonary embolism, this is not true of phlebothrombosis, in which a very real danger exists. Since signs of inflammation are either completely absent or minimal in phlebothrombosis, phlebography is frequently a helpful diagnostic procedure.

The simple and safe roentgenographic technic requires the placing of the patient in a recumbent position with a 7 × 17 film under his lower leg and a 14 × 17 film under his thigh. A tourniquet is applied to the thigh and the entire leg is internally rotated. Then, 25 c.c. of diodrast are injected into a superficial vein on the dorsum of the foot or ankle at the rate of 1 c.c. per second. Approximately thirty seconds after the injection, the exposure is made, at a target-film distance of 6 feet. Where the side of involvement is not known, phlebograms of both legs are obtained.

Whenever in phlebothrombosis a defect in the venous system is demonstrated, immediate operation is indicated. This should consist in either ligation of the involved vein above the site of the thrombus or thrombectomy.

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RADIOTHERAPY

Dosage Measurements in Contact Roentgen Therapy. Edith H. Quimby and Elizabeth F. Focht. Am. J. Roentgenol. **50:** 653–668, November 1943.

For the soft roentgen rays obtained with the Philips apparatus, ordinarily operated at 44 kv., the usual measuring instruments are inaccurate. The "air walls" of thimble chambers absorb an appreciable percentage of the radiation produced at this low voltage. Also, in a chamber having an inside diameter of even a few millimeters, at distances of the order of 2 cm. from the source of radiation, the distribution of ionization is such that the reading cannot be specifically assigned to a definite distance. Furthermore, the very high roentgen-ray output of this tube necessitates the use of special instruments for measurements at or near the contact position. For investigations of the beam in air a "mesh chamber" was used. For measuring on or in the phantom, an extrapolation type of chamber of very small size was employed. The construction of these chambers is described in detail.

Absorption curves for aluminum and for presdwood, made with the "mesh chamber," are given for 44 kv. roentgen rays. The matter of the measurement of these rays with small carbon-lined chambers was investigated, and it is concluded that "such chambers are not suitable for measurement in roentgens of x-ray beams in this voltage region. With certain precautions, they can be used to obtain relative surface and depth doses within the limits of accuracy required in clinical work." Curves and tables are presented showing depth dose data for filtered and unfiltered beams, for various fields and distances, using a presdwood phantom. The distribution of stray radiation around the tube is shown diagrammatically. The standard lead rubber fluoroscopic apron is found to afford satisfactory protection from these rays. The tube should never be held by the operator while a treatment is being given, but should be supported rigidly by some mechanical arrangement so as to prevent exposure of the face and arms. The tube should be as far from the controls as possible in every case.

A theoretical analysis was made of the radiation produced at 45 kv. (peak) and of the portion of this which is absorbed and results in the measured ionization. It is stated that the results are in reasonably good agreement with the experimental data.

CLARENCE E. WEAVER, M.D.

Depth Dose Measurements in Contact Roentgen Therapy on a Biological Test Object (Rabbit's Skin). Henry Quastler. Am. J. Roentgenol. **50:** 669–676, November 1943.

Measurement of depth dose distribution in contact roentgen therapy has been made by several workers. While the resulting curves are fairly similar to each other, yet their differences are too large to be negligible. The author used the smooth inner skin of the rabbit's ear as a biological test object. Depth dose estimates were established by comparing reactions to doses of 50-kv. (peak) radiation delivered directly with those given through layers of absorbent material of known thickness. A localizer cone of brass with a circular opening of 12 mm. diameter was used. Beeswax was employed as the phantom material. Three or four control fields were irradiated with geometrically graded doses. The test fields were irradiated through wax blocks of different thickness ranging from 0.3 to 15 mm. The doses applied were chosen so that the presumable depth dose would fall within the range covered by the control fields. Check-up examinations were made until the skin reactions reached optimum definition, usually about three weeks after irradiation. At every examination it was estimated—by comparison with the reaction on the control fields—which dose would have provoked, on the same rabbit, on direct irradiation, a reaction as seen on a test field. This dose was called the "equivalent dose." The percentage depth doses were calculated by expressing equivalent doses in terms of the doses delivered to the surface of the wax blocks.

From these experiments a depth dose curve is plotted based on the reaction of the rabbit's ear. It is concluded that this curve is (1) reasonably exact and (2) presumably identical with or very similar to an ionometric depth dose curve. The "rabbit ear curve" is almost the same as the curve found by Quimby and Focht (see previous abstract) on measurement with the extrapolation chamber. It is assumed that the

extrapolation chamber and rabbit's ear yield identical results because both are flat. The chambers used by other authors are considerably deeper and therefore less apt to register a steep decrease of intensity within a small space. Agreement between one ionometric method and the biological reaction used was found within the range of observation (contact distance, no additional filter, field of 12 mm. diameter, depths up to 1.5 cm.). There is every reason to believe that the same agreement would be found with other conditions.

CLARENCE E. WEAVER, M.D.

Local Application of Sulphanilamide Powder in Radiotherapy. Alexander A. Charteris. Brit. M. J. 2: 577–578, Nov. 6, 1943.

The author presents a short but timely article on the use of sulfanilamide powder in conjunction with radiotherapy of ulcerative tumors. He points out that in many such cases sepsis becomes a definite problem for the radiotherapist. In growths on the perineal region and in the nose, it is highly important to combat the development of ulcers, which commonly follow when sufficient radiation is given. The part is sprinkled with sulfa powder two or three times at daily intervals and a moist dressing is applied. The use of a lanolin or vaseline dressing is also advised.

Q. B. CORAY, M.D.

NEOPLASMS

Lymphosarcoma of the Stomach. Harry Yarnis and Ralph Colp. Gastroenterology **1:** 1022–1039, November 1943.

Of 250 patients admitted to the Surgical Service of the Mount Sinai Hospital, from 1937 to 1943, in whom a diagnosis of neoplasm of the stomach had been made, 8 were found to have lymphosarcoma, an incidence of 3.2 per cent. These 8 cases (7 small-round-cell lymphosarcomas, 1 reticulum-cell sarcoma) are presented, with a discussion of the clinical, roentgenologic, gastroscopic, surgical, and pathologic aspects.

Grossly, gastric lymphosarcoma occurs in two forms; in one, the cells are diffusely infiltrating, causing an apparent simple hypertrophy of the rugae; in the other, definite tumor formation may be present, often with ulceration. The first form may be overlooked during surgical exploration, for the stomach not only appears normal externally but seems to be normal to palpation. The second type, indistinguishable in its gross characteristics from carcinoma, may occupy any region of the stomach or involve it completely. The authors believe that in some cases the involvement of the stomach may be considered an expression of a generalized lymphosarcomatosis, while in others it should be regarded as a localized, focal tumor demanding resection.

The average age of the patients in this series was 54.5 years, with the sexes equally represented. The average duration of symptoms was seven months. Upper abdominal pain was the most characteristic complaint.

Opinions differ as to whether giant rugae play an important part in the roentgen diagnosis of lymphosarcoma. The presence of a large ulcer crater in a young person with a relatively short history should arouse suspicion of a lymphosarcoma.

Gastroscopy may prove of definite diagnostic value in identifying the diffusely infiltrating type of lymphosarcoma with numerous submucous tumors. Biopsy, through an open esophagoscope, should be done in those cases in which roentgenographic study or gastroscopic observation points to the presence of a malignant lesion near the cardia.

Two of the 8 patients in this series died postoperatively of peritonitis. Three patients were treated by gastric resection with subsequent irradiation; one of these died eleven months after the onset of symptoms; one had distant metastases seven months after operation; the third patient was still receiving radiotherapy at the time of this report. Two patients, in whom the diagnosis of lymphosarcoma was established by gastrotomy and biopsy, were treated by radiotherapy; one died twelve months after the onset of symptoms and one is alive and well three years after exploratory laparotomy. One patient, in whom the diagnosis was made by esophageal biopsy, was treated by irradiation alone and died one year after the onset of symptoms. These poor results are comparable with those recorded by others.

Roentgenograms are reproduced.

Wilms' Tumor of the Kidney: A Clinico-Pathologic Study of 44 Proved Cases. Wilson Weisel, Malcolm B. Dockerty, and James T. Priestley. J. Urol. **50:** 399–413, October 1943.

Of the 44 cases of Wilms' tumor recorded in this paper from the Mayo Clinic, half occurred in the first three years of life; 8 patients were between the ages of twelve and fifty-nine. Twenty-nine of the series were female. In no instance was the condition bilateral.

The symptoms, in order of importance, were abdominal mass, fever, weight loss, cachexia, hematuria, and pain. The average duration was four and a half months. The clinical and laboratory signs included ascites, venous obstruction, emaciation, anemia, leukocytosis, albuminuria, microscopic hematuria, and x-ray evidence of a mass.

Striated muscle was found in 45 per cent of the tumors. Viable cells were present in all tumors after irradiation (except one case with early death from metastases). In view of this, the authors conclude that it is unwise to allow too long an interval before operation.

There have been no five-year cures of Wilms' tumor by radiotherapy alone. The treatment of choice is immediate nephrectomy, followed by irradiation, if the tumor can be delivered without undue risk. Otherwise preoperative irradiation may be given for two to three weeks only, followed by nephrectomy and postoperative irradiation.

The majority of the authors' series died within one year. Seven survived two to twenty years.

EDWIN L. LAME, M.D.

Retothel Sarcoma of the Prostate Gland: Report of a Case. Jack D. Kirshbaum, Herbert S. Larkin, and Harry Culver. J. Urol. **50:** 597–607, November 1943.

Only 162 cases of sarcoma of the prostate have been found in the literature. Lymphosarcoma is the rarest type. A case of reticulum-cell lymphosarcoma or so-called retothel sarcoma is recorded in the present paper.

The patient was a 22-year-old white male complaining of dysuria, pain in the perineum, and fever of ten days' duration and "prostate trouble" for one year.

Examination revealed an enlarged, irregular, boggy prostate, warm and tender and definitely fluctuant, with infiltration high on the right side. A diagnosis of prostatic abscess was made, and perineal prostatotomy produced some sterile serous material. Clinical improvement followed. Four months later, the patient was readmitted because of swelling of the right leg for one week and abdominal pain. Rectal examination revealed a firm, tender mass filling the pelvis, palpable suprapubically. At operation, tumor tissue was scraped out from the periprostatic and perivesical areas. A chest plate revealed opaque patches in the right lung field with suggestion of fluid. A pyelogram showed a large hydroureteronephrosis on the right but no visualization was obtained on the left. A cystogram revealed distortion of the bladder base and lifting of the entire bladder out of the pelvis. The patient gradually improved and weekly x-ray treatments were instituted. During the next fifteen months, he received 11,948 r (factors not stated) over the thighs, gluteal regions, lumbar regions, inguinal regions, and right and left upper and lower quadrants. Following this, pyelograms revealed a normal right pelvis and calices, with some dilatation on the left. The bladder was normal.

Approximately three years after onset of symptoms, the patient was admitted in terminal uremia. Autopsy revealed reticulum-cell lymphosarcoma of the prostate gland with metastases to the bladder, liver, lungs, left adrenal and periaortic lymph node, and bilateral pyelonephritis.

The authors state that only rhabdomyosarcomas of the prostate are universally recognized. Ewing, Stirling, and Ash believe that primary lymphosarcoma of the prostate has not been proved, while Bumpus, Taschiro, and others have reported 15 cases as such. The average age in these cases was 39.6 years, the majority of the patients surviving only a few months. The three-year survival in the present case is the longest recorded. Symptoms do not usually occur until the tumor has infiltrated the bladder. They vary with the direction and rapidity of growth.

Diagnosis is based on urinary complaints or disturbance of bowel habits in a patient under forty (5 of the 15 reported cases were in patients of 45 or over); enlarged prostate, smooth and oval and of varying consistency; tumor fixed to the pelvis or a part of the prostate; metastatic lesions in the pelvic bones and chest; elevation of bladder out of the pelvis, with a constant filling defect at the base and diminished capacity. Cystoscopy reveals a distorted urethra, bladder infiltration, and perhaps elevation of the bladder floor.

The authors believe radical surgery futile. Radium and roentgen therapy alone give the best results, although recurrences ultimately occur. The comparatively long survival in their case is attributed to avoidance of radical surgery and the use of massive doses of deep x-ray over an extended period.

C. R. PERRYMAN, M.D.

Tumor of Testicle: Analysis of Results Obtained in 50 Patients Treated by X-Ray Therapy. George Gilbert Smith. J. Urol. **50:** 585–589, November 1943.

Reporting 50 cases of cancer of the testicle, the author discusses methods of diagnosis and treatment, with special reference to the value of the x-ray as a therapeutic agent. In his series the age variation was from 16 to 69 years, with 34 per cent of the cases appearing in the fourth decade. In all but 2 cases orchiectomy was performed as early as possible without preliminary irradiation, and the author believes that the time thus gained is of more value to the patient than the possible advantage of x-ray treatment. The diagnosis of teratoma or embryonal carcinoma was made in each case, but there is no practical value in making a distinction between the two, since mixed elements are present in tumors which appear to be derived from a single embryonic layer. There was one embryonal carcinoma of the epididymis; the remainder of the series involved the testicle itself. In 2 cases the growths were bilateral.

Besides the examination of the tumor, there should be a careful search for metastases. The supraclavicular nodes in particular should be observed, for if they are enlarged there is a more than equal chance that the lung or mediastinum is already the site of metastases. Chest and abdominal films may disclose metastatic lesions, and intravenous pyelograms are frequently desirable. Besides aiding in diagnosis, these films furnish a means of checking the results of treatment.

The most common location of metastatic lesions is in the juxta-aortic nodes on the side of the affected testis (34 per cent). In 48 per cent of the cases metastases developed, and of these, 87 per cent were discovered within two years following orchiectomy. This warrants the assumption that, if free of metastases after two years, the patient has a nine out of ten chance of being cured.

The author questions the prognostic value of gynecomastia or a positive prolan test. Statistical data do not prove that the presence of these signs indicates a higher grade of malignancy. Early removal of the tumor increases the chances of survival, although an apparent cure was obtained in one patient who had noticed an increase in the size of his testicle seven years before orchiectomy.

The value of x-ray irradiation postoperatively is definitely established by the author's statistics. Of 8 patients who were without metastases and who were not treated by x-ray, 2 lived over four years. Of 23 patients who were without metastases and who were treated by x-ray, 13 were in good health four or more years after orchiectomy. Many of the poor results followed incomplete irradiation of the abdomen, with metastases developing in the unirradiated areas. The ultimate results of x-ray treatment postponed until metastases developed were not good. Of 12 patients with metastases, 3 responded well to radiation; one is alive over four years after his operation. The conclusion drawn is that at least 1,600 r should be given the anterior abdomen and an equal dose applied to the abdomen posteriorly, the entire abdominal area being included in each field. Chorionepithelioma is so universally fatal that irradiation is useless. Patients with abdominal metastases should have the mediastinal region treated as well as the abdominal area, since in half of the patients with upper abdominal metastases chest lesions developed also.

DEWAYNE TOWNSEND, M.D.

X-Ray Therapy of Benign Uterine Bleeding and Fibromyoma. Saul J. Tamarkin. Ohio State M. J. **39:** 1023–1026, November 1943.

Definite contraindications to radiation therapy for uterine bleeding are: adnexal tumors, cysts, associated acute inflammations such as appendicitis and salpingi-

tis, degenerating submucous or subserous pedunculated fibroids, calcified fibroids, and malignant neoplasms of both the cervix and body. Chronic pelvic inflammatory disease does not necessarily prohibit the use of x-ray therapy, as evidenced by the good results obtained in several patients treated despite the presence of a "frozen pelvis." Fibromyomata the size of a six-month pregnancy and over should be removed surgically. The danger of sarcomatous degeneration of a fibroid is small, reported statistics showing an incidence of less than 0.5 per cent. Surgery is recommended in preference to irradiation in patients over fifty-five.

The author reports the effects and results of x-ray therapy for benign uterine bleeding and fibromyoma in 126 cases seen from 1932 to 1942. There were no fatalities. Menopausal symptoms were mild, 15 per cent of the patients having no symptoms whatsoever. Five highly nervous, underweight women suffered severe radiation sickness, but this was controlled by large doses of thiamin, liver extract, and intravenous glucose, with hospitalization necessary in 3 cases. Mild erythema, bronzing of the skin, and temporary pubic epilation occurred in most instances. Most of the younger patients reported no change in libido. Sexual relations were permitted during treatment and no contraceptive measures were deemed necessary. Following the treatment, 88 per cent had one menstrual period that was usually more severe than ordinarily. Three patients had two periods. Bleeding recurred in 2 patients in four months and a second course of therapy was given. One patient, who continued to "spot" for three months, was found on curettage to have a fundus carcinoma and was treated by hysterectomy. Two recurrences of bleeding after six months were due to excessive hormonal therapy.

Twenty-seven of the patients in this series were under forty years of age and had some serious organic disease, as well as severe bleeding, dysmenorrhea, or fibroids. The author does not believe in "temporary castration" x-ray therapy in these young women and advises abortion in all patients who become pregnant after pelvic irradiation, because of the theoretical danger of damage to the ovum and birth of an abnormal child. X-ray therapy to the spleen and pituitary rather than to the pelvis is recommended in puberal bleeding.

The author gives eight to fourteen treatments, one treatment daily, alternating one large anterior and one posterior field, using 180 kv., Thoraeus filter, 50 cm. F.S.D., with a total of 500 r to 600 r to the ovaries.

Although radium gives satisfactory results and is especially useful in fibrosis uteri, it is not to be preferred, because of its local caustic effect, which may account for the occasional exacerbations of chronic pelvic inflammation and cervical stenosis.

LESTER M. J. FREEDMAN, M.D.

Leucemia and Pregnancy: A Case Report and Review of the Literature. Joseph L. McGoldrick and Warren A. Lapp. Am. J. Obst. & Gynec. **46:** 711–718, November 1943.

A case of chronic myelogenous leukemia associated with pregnancy is recorded. The diagnosis of leukemia was made a year and a half before the patient entered the hospital in labor (Dec. 19, 1942), and she had been treated elsewhere by irradiation of the spleen —1,350 r—with reduction of the white cell count from 176,000 on Oct. 2, 1941, to 80,000 on April 15, 1942. On the day of admission the red cell count was 3,200,000; hemoglobin 55 per cent; white cell count 250,000 with 40 per cent polymorphonuclear neutrophils, 10 per cent myeloblasts, 25 per cent metamyelocytes, 15 per cent myelocytes, and 10 per cent lymphocytes.

The patient delivered spontaneo sly a stillborn infant after fourteen and a half hours in labor. She left the hospital a week later, contrary to advice, having refused transfusions and other therapeutic measures. On June 2, 1943, she received an additional 600 r to the spleen, at the hospital where the original diagnosis had been made, and was reported in fair condition.

Seventy-nine cases were collected from the literature in which the diagnosis of leukemia associated with pregnancy was substantiated sufficiently for statistical purposes. On the basis of blood studies 34 were classified as acute and 45 as chronic.

Of the acute cases, 17 were of the myelogenous type, 9 were lymphatic, 2 hemocytoblastic, and 3 were unclassified. [The authors do not account for the other 3.] The onset of the disease in all but 2 instances occurred after the patient became pregnant. The maternal mortality in the acute cases was 100 per cent. Four patients died during pregnancy, 5 during parturition, and 22 post partum, only 2 living as long as fourteen days after delivery. The fetal mortality was 60 per cent. Severe post-partum hemorrhage occurred in 5 cases and was fatal in 2. Of 20 patients in whom pregnancy was not interrupted, 9 proceeded to term and 11 had spontaneous premature labor. Only 3 infants were stillborn when the patient went to term.

The prognosis was better in the chronic cases, 41 of which were of the myelogenous and 3 of the lymphatic type. In only 6 of these cases did the disease develop during pregnancy. The maternal mortality was 36.5 per cent. One patient died undelivered, 1 during parturition, 1 shortly post partum, and 12 within a year after delivery. Twenty patients went on to full term. Labor began spontaneously at 8 1/2 months in 2 cases and at 8 months or less in 8 cases. The fetal mortality was 16.4 per cent. Severe hemorrhage occurred in 3 instances and was fatal in 1.

The author calls attention to the fact that patients subjected to considerable irradiation by either roentgen rays or radium, in whom consequent sterilization might well be considered a possibility, have conceived and gone to term, delivering normal infants.

Though acute exacerbation of the leukemic process may follow parturition, the course of the disease for the most part seems to be affected little, if at all, by the pregnancy. In a few instances, overdistention of the abdomen as a result of the expanding uterus in the presence of a greatly enlarged liver and spleen has caused discomfort. Autopsies have frequently shown extensive leukemic infiltrations of the genital tract, especially of the ovaries and uterus, which would seem to limit the frequency of pregnancies.

No leukemic child has ever been delivered of a leukemic mother, in spite of the fact that leukemic cells, much like neoplastic cells, seem able to invade surrounding and distant tissues.

Since the course and outcome of the disease are little affected by the progress of the pregnancy, the latter may be permitted to continue. The undesirable effects of irradiation on the fetus preclude its use in the pregnant woman.

STEPHEN N. TAGER, M.D.

NON-NEOPLASTIC DISEASE

Roentgen Therapy of Interstitial Pneumonia. Albert Oppenheimer. J. Pediat. **23:** 534–538, November 1943.

For the treatment of interstitial pneumonia in children Oppenheimer describes the following routine procedure. The patient is given one roentgen-ray treatment with 140 kv., 20 ma., 0.5 mm. Cu plus 1.0 mm. Al filtration, the dose varying between 20 and 90 r measured on the skin, through portals 15 cm. square directed to the involved region with inclusion of the hila. The anode-skin distance is 35 cm. in infants and in children with flat chests and thin integuments, but 50 cm. in stocky and adipose patients. Dosage is determined by the age of the patient and the duration of the disease, in accordance with the rules applying to roentgen therapy of inflammatory lesions.

Following roentgen irradiation with small doses, rapid and consistent improvement of the clinical condition took place in 33 of 36 patients with interstitial pneumonia. Treatment with doses exceeding 100 r during acute stages resulted in severe constitutional reactions.

Low-Dosage Irradiation in the Treatment of Amenorrhea: An Analysis of an Additional 92 Cases. Charles Mazer and Rose Greenberg. Am. J. Obst. & Gynec. **46:** 648–652, November 1943.

On the basis of earlier studies covering 238 cases and Reidenberg's long-term review of 136 of these (Am. J. Obst. & Gynec. **45:** 971, 1943. Abst. in Radiology **42:** 103, 1944), the authors believe it reasonable to assume that low-dosage ovarian irradiation for functional menstrual disturbances is without deleterious effects on the offspring of the first generation.

That subminimal doses of roentgen rays, such as are employed in diagnostic procedures, do not injure even the sensitive ovarian cells of infants is clinically established. That the cells of the mature ovary are more resistant to irradiation is well known. The problem is, therefore, purely a question of dosage in relation to the sensitiveness of the tissues exposed to the rays.

The present series of 92 patients treated for amenorrhea received low-dosage irradiation of the pituitary gland and ovaries. Thirteen of the patients were between seventeen and twenty years of age; 71 were between twenty-one and thirty; and 8 were between thirty and thirty-six. The possible presence of pregnancy was eliminated by a biologic test, unless the patient happened recently to have menstruated. Only those who were physically well, as shown by clinical and laboratory studies, were selected for treatment.

All patients were followed for a period of one or more years. Instances of improvement or restoration of the menstrual function for a period of less than a year are grouped as failures. Adherence to these rigid requirements, set up as a guard against erroneous deductions, is believed to justify the presentation of this report.

The 92 patients were treated by several radiologists with the following technic: 135 kv., 5 ma., F.S.D. 35 cm., 0.25 mm. Cu and 1 mm. of aluminum filtration, anterior pelvic field. Depending on the size of the pelvis and the thickness of the abdominal wall, a dose of 50 to 90 r (in air) is given, repeated three times at intervals of one week. The pituitary gland is treated with the same dosage at the same time through a 5 × 5-cm. field just above and posterior to the mid-point of a line joining the outer canthus of the eye and the external auditory meatus.

Ten of the 92 patients had not menstruated for periods varying from sixteen months to six years, with an average of two years and eight months for the group. Five of these (50 per cent), including the one with total amenorrhea for six years, have been menstruating regularly during a follow-up period averaging three years. Twelve other patients had menstruated at intervals of six months. Eight of these (66 per cent) have been menstruating normally during a follow-up period averaging two and a half years. Sixty-eight patients had a milder type of amenorrhea, with menstruation at intervals of two to four months. Fifty-two of these (76.5 per cent) have been menstruating normally during a follow-up ranging from one to five years, with an average of two years and seven months for the entire group. One patient, aged eighteen years, who despite intensive organotherapy had never menstruated, responded promptly to low-dosage irradiation.

The percentage of cures is seen to be inversely proportional to the severity of the amenorrhea. Thus, those who had menstruated at intervals of two to four months yielded the highest proportion of cures (76.5 per cent) and those who had not menstruated at all for sixteen months to six years the lowest percentage (50 per cent).

Seventeen patients in the series had also experienced episodes of prolonged uterine bleeding following variable periods of amenorrhea. In these, control of the bleeding was the first consideration. This was accomplished in 12 of the 17 by injections of chorionic gonadotropin in daily doses of 500 international units as long as the bleeding persisted. This hormone is known to have no stimulating effect on the human ovary. These patients were subsequently irradiated but in only 6 was normal menstrual rhythm established.

Sterility was an associated and important factor in 54 of the patients. In the majority some factor other than an endocrine one, such as non-patency of the fallopian tubes, coexisted and was simultaneously treated. Thirty of the group conceived at variable intervals after termination of treatment. Twenty-eight of them delivered healthy infants; abortion occurred in the remaining two during the first trimester of pregnancy. Complete restoration of the menstrual cycle for over a year in 19 of the 21 women who conceived soon after treatment implies that conception was the result of improved ovarian activity. Two of the 28 successful pregnancies followed a second course of low-dosage irradiation, given because the first attempt failed to restore completely the menstrual function.

A survey of the literature on low-dosage irradiation of the pituitary gland and ovaries, as employed for the relief of amenorrhea, reveals no adverse effects either on the patients or their offspring. Instances of harm recorded in the literature are traceable to heavy irradiation for uterine fibroids and kindred conditions.

The importance of employing a uniform technic and dosage is emphasized, for the boundary line between the clinically effective and the injurious dose of roentgen rays has not been determined.

STEPHEN N. TAGER, M.D.

INDEX TO VOLUME 42

AUTHORS AND SUBJECTS

Note: In the following Index some departures have been made from the arrangement employed in indexing the past volumes of Radiology. The most radical of these is combining in a single index both authors and subjects, as in the *Cumulative Index of Radiology*. We believe that this is a real improvement from the point of view of simplicity and usefulness. Other changes consist chiefly in matters of style, and these, too, have been adopted to make the semi-annual indexes conform as closely as possible to the *Cumulative Index*.

A

ABESHOUSE, BENJAMIN S.: Ureteral ectopia: report of a rare case of ectopic ureter opening in the uterus and a review of the literature (ab), March, 312

ABORTION
  therapeutic
  —by x-rays (ab), Carlos E. Gárciga, Jan., 104

ABRAMSON, DANIEL J.: Solution of vesical phosphatic calculi (ab), May, 520

ABSCESS
  See also Infection
  perinephritic
  —in infants and children; study of 26 patients surgically treated (ab), Henry Swan, April, 420
  subphrenic
  —left subdiaphragmatic abscess; case (ab), Gervase J. Connor, March, 309
  —total subphrenic abscess; case, David V. LeMone and William Grant Cooper, Jr., March, 283
  supralevator
  —(ab), Eugene A. Gaston and Lyman O. Warren, May, 514
  tuberculous
  —treatment of cold abscesses by combined surgical drainage and roentgen therapy (ab), Alfredo Pavlovsky, May, 526

ACETABULUM
  fractures
  —traumatic dislocation of hip with fracture of acetabulum (ab), Alfred M. Okelberry, Jan., 100

ACROMIOCLAVICULAR JOINT. See Shoulder

ADAMANTINOMA. See Tumors, adamantinoma

ADAMS, PAYSON: Radiopaque membranous pyelitis following sulfonamide therapy (ab), April, 419
  Traumatic rupture of the kidney (ab), April, 419

ADAMS, W. E., and THORNTON, T. F., Jr.: Bronchogenic cysts of the mediastinum, with report of 3 cases (ab), March, 302

ADENOMA. See Kidneys, tumors

ADENOMYOSIS. See Endometriosis

ADHESIONS
  abdominal
  —intestinal strangulating obstruction with negative roentgenologic findings (ab), Leon Goldman, Jan., 96

ADRENALS
  cancer
  —bilateral carcinoma of cortex with metastasis to iliac bone (ab), Mather Cleveland and Leila C. Knox, March, 309
  roentgenography
  —laminagraphy in visualization (ab), Seymour F. Wilhelm, March, 309

AGERTY, H. A., ZISERMAN, A. J., AND SHOLLENBERGER, C. L.: Case of perforation of the ileum in a newborn infant with operation and recovery (ab), June, 608

ALBERS-SCHÖNBERG DISEASE. See Osteosclerosis fragilis

ALIMENTARY TRACT. See Colon; Duodenum; Esophagus; Intestines; Rectum; Stomach

ALLEN, E. V., and BAIRD, LESTER W.: Pneumonia in the Army (ab), June, 606

ALLISON, P. R., JOHNSTONE, A. S., and ROYCE, G. B.: Short esophagus with simple peptic ulceration (ab), Jan., 94

AMENORRHEA
  therapy
  —low-dosage irradiation in treatment of amenorrhea: analysis of additional 92 cases (ab), Charles Mazer and Rose Greenberg, June, 618
  —low-dosage irradiation to pituitary gland and ovaries in amenorrhea and dysfunctional uterine bleeding: long-time survey (ab), Leon Reidenberg, Jan., 103

AMERICAN COLLEGE OF RADIOLOGY
  —examinations, June, 599

AMERICAN CONGRESS OF PHYSICAL THERAPY
  —annual meeting, June, 599

ANDERSON, MARGARET. See **ROBINOW, MEINHARD**

ANDERSON, RUBERT S. See **FRIEDEWALD, WM. F.**

ANÉ, J. N., and MENVILLE, LEON J.: Analysis of roentgen pelvimetry by the Johnson stereoroentgenometer in 379 cases (ab), Jan., 101

ANEMIA
  erythroblastic
  —with review of literature (ab), James M. Flynn, April, 424
  pernicious
  —"accordion heart" caused by anemia (ab), Rodolfo F. Scharer and Eugenio R. Pietrafesa, June, 607
  splenic
  —radio-phosphorus; an agent for the satisfactory treatment of polycythemia and its associated manifestations; report of case of polycythemia secondary possibly to Banti's syndrome (ab), Lowell A. Erf and Harold W. Jones, May, 526

ANEURYSM
  aortic
  —congenital aneurysmal dilatation associated with arachnodactyly (ab), Ridgely W. Baer, Helen B. Taussig, and Ella H. Oppenheimer, March, 305
  —dissecting aneurysm (ab), R. Bruce Logue, Feb., 201
  —dissecting aneurysm of abdominal aorta (ab), Eugene DeAngelis, March, 306
  —dissecting aneurysm, with antemortem diagnosis; 2 cases (ab), M. E. Thomas and A. Elizabeth Garber, March, 304
  —multiple saccular aneurysms (in syphilitic patient) with roentgen and necropsy findings (ab), F. B. Mandeville, Jan., 93
  —syndrome of rupture of aortic aneurysm into pulmonary artery: review of literature with report of 2 cases (ab), Richard E. Nicholson, March, 305
  —with rupture into pulmonary artery (ab), Herbert J. Schattenberg and William H. Harris, Jr., March, 305
  cardiac
  —report of case with correlation of clinical, radiologic, and electrocardiographic findings (ab), Driver Rowland, March, 304
  carotid
  —radiologic changes in carotid-cavernous aneurysm (ab), R. A. Kemp Harper, Feb., 202
  pulmonary
  —aneurysm of pulmonary artery; report of case in which aneurysm apparently developed under observation (ab), Alfred S. Hartwell and Irvin L. Tilden, June, 606

ANGIOMA. See Tumors, angioma

ANKLE
  abnormalities
  —congenital talonavicular synostosis; case report of rare anomaly (ab), D. H. O'Donoghue and L. Stanley Sell, May, 517
  wounds and injuries
  —osteochondritis dissecans of astragalus (following ankle sprains) (ab), Milton C. Cobey, May, 517

ANTHRACOSIS. See Pneumoconiosis

ANTRUM OF HIGHMORE. See Maxillary Sinus

ANUS
  —roentgen therapy in ano-vulvar pruritus (ab), José L. Molinari and Aníbal Lemos Ibáñez, May, 526

AORTA
  —anomalous origins of posterior intercostal arteries from 9th5 thoracic aortas; their role in fractures of ribs (ab), Myrtelle M. Canavan, May, 513
  —aortic arch and cardiac mensuration, David E. Ehrlich, April, 382
  abnormalities
  —constricting double aortic arch; case (ab), Peter A. Herbut and Thomas T. Smith, April, 411
  —juvenile elongation (ab), F. Y. Khoo, March, 306
  —right aortic arch, with report of 8 cases, David Eisen, June, 570
  aneurysm. See Aneurysm, aortic
  rupture. See Aneurysm, aortic
  stricture
  —osteopathia condensans disseminata associated with coarctation of aorta; case (ab), George S. Phalen and Ralph K. Ghormley, Feb., 206
  syphilis
  —multiple saccular aneurysms (in syphilitic patient) with roentgen and necropsy findings (ab), F. B. Mandeville, Jan., 93

APPARATUS. See Roentgen Rays, apparatus

APPENDIX
  —intussusception (ab), Kenneth Fraser, Feb., 203
  calculi
  —case (ab), Antonio M. Tripodi and Alfred L. Kruger, April, 415
  fistula. See Fistula

ARACHNODACTYLIA
—congenital aneurysmal dilatation of the aorta associated with arachnodactyly (ab), Ridgely W. Baer, Helen B. Taussig, and Ella H. Oppenheimer, March, 305
ARCE, JOSÉ: Diverticulum of the right primary bronchus (ab), May, 512
ARMY. See Military Medicine and Surgery
ARNOLD-CHIARI DEFORMITY. See Brain, abnormalities
ARTERIES
intercostal
—anomalous origins of the posterior intercostal arteries from 9\|5 thoracic aortas: their role in fractures of the ribs (ab), Myrtelle M. Canavan, May, 513
pulmonary
—aneurysm of pulmonary artery; report of case in which aneurysm apparently developed under observation (ab), Alfred S. Hartwell and Irvin L. Tilden, June, 606
—aortic aneurysm with rupture into pulmonary artery (ab), Herbert J. Schattenberg and William H. Harris, Jr., March, 305
—atrial septal defect; report of two cases in which there was recurrent laryngeal nerve paralysis (ab), Herman Erlanger and Samuel A. Levine, May, 513
—congenital dilatation; case (ab), H. L. Heimann and M. M. Posel, June, 607
—syndrome of rupture of aortic aneurysm into pulmonary artery; review of literature with report of 2 cases (ab), Richard E. Nicholson, March, 305
ARTHRITIS. See Shoulder; Spine, arthritis
ARTHROGRAPHY. See Knee, roentgenography
ASHBURN, FRANK S. See **DOCKERTY, MALCOLM B.**
ASTRAGALUS
—osteochondritis dissecans of astragalus (following ankle sprains) (ab), Milton C. Cobey, May, 517
ATELECTASIS. See Lungs, collapse
ATLAS AND AXIS
dislocations
—syndrome of atlanto-axial dislocation (ab), G. M. Bull, Jan., 100

B

BACKACHE
—herniation of nucleus pulposus as complication of pre-existing low back instability (ab), Edwin M. Deery, Feb., 208
BACON, RALPH D.: The fat meal—its value in cholecystography (ab), June, 609
BAER, RIDGELY W., TAUSSIG, HELEN B., and OPPENHEIMER, ELLA H.: Congenital aneurysmal dilatation of the aorta associated with arachnodactyly (ab), March, 305
BAGASSOSIS. See Pneumoconiosis
BAIRD, LESTER W.: Roentgenologic diagnosis of carcinoma of the colon (ab), March, 307
——See **ALLEN, E. V.**
BAIRD, LESTER WHITE (obit), Feb., 191
BAKER, CHARLES FREDERICK (obit), April, 400
BAKER, JOEL W., and CARLILE, THOMAS: Solitary diverticulitis of the cecum (ab), Jan., 97
BAKER, LENOX D.: Ankylosing spondylarthritis: Marie-Strümpell arthritis: roentgen and orthopedic therapy (ab), Feb., 207
BAKER'S CYST. See Synovial Membrane, cysts
BALL, ROBT. P., and GOLDEN, ROSS: Roentgenographic obstetrical pelvicephalometry in the erect posture (ab), Jan., 101
BANTI'S DISEASE. See Anemia, splenic
BARDEN, ROBERT P.: Similarity of clinical and roentgen findings in children with Ewing's sarcoma (endothelial myeloma) and sympathetic neuroblastoma (ab), June, 612
BARDEN, STUART P.: Two unusual cases of urinary tract calculi, March, 285
BARGEN, J. ARNOLD. See **SEEFELD, PHILIP H.**
BARNS, H. H. FOURACRE: March fracture of the metatarsal bones (ab), June, 611
BASOPHILISM (Cushing's Syndrome). See Pituitary Body, diseases
BAUER, A. A.: Considerations on 1,000 chest x-ray examinations performed on men applying for employment (ab), Jan., 90
BAUMRUCKER, GEORGE O.: Estimation of renal function based on specific gravity changes following intravenous urography (ab), May, 518
BAYLIN, GEORGE J., and WEEKS, KENNETH D.: Some roentgen aspects of pancreatic necrosis, May, 466
BEHNE, KURT FRIEDRICH (obit), April, 400
BEILIN, DAVID S.: Clinical features, diagnosis, and treatment of carcinoma of the colon and rectum, June, 539
BELANGER, W. GEORGE, and DYKE, CORNELIUS G.: Roentgen diagnosis of malignant nasopharyngeal tumors (ab), Feb., 196
BENDS. See Caisson Disease
BENSON, RAYMOND E., DIXON, CLAUDE F., and WAUGH, JOHN M.: Nonmeckelian diverticula of the jejunum and ileum (ab), April, 414
BENSON, R. R. See **PAUL, L. W.**
——See **POHLE, ERNST A.**
BERKAN, HENRY S. See **CAMIEL, MORTIMER R.**
BERMAN, J. K.: Nontuberculous empyema thoracis in children (ab), Jan., 91
BERSACK, S. R.: Carcinoma of the esophagus in association with achalasia of the cardia, March, 220
BICK, MALCOLM W., and EPSTEIN, BERNARD S.: Electrocardiographic changes during pneumoencephalography (ab), March, 300
BILE
—elimination of administered zinc in pancreatic juice, duodenal juice, and bile of dog as measured by its active isotope (Zn^{65}) (ab), M. Laurence Montgomery, G. E. Shipline, and I. L. Chaikoff, May, 529
BILIARY TRACT
See also Bile; Gallbladder; Liver
roentgenography
—visualization with air and barium following a barium meal (ab), Daniel B. Faust and Chas. S. Mudgett, March, 308
BIRNKRANT, MILTON: Traumatic serous cyst of the lesser omentum, Jan., 74
BIXLER, LOUIS C., STENSTROM, K. WILHELM, and CREEVY, C. D.: Malignant tumors of the kidney: review of 117 cases, April, 329
BLACKFORD, L. MINOR: Hemangioma of vertebra with compression of cord: report of case cured with radiation fourteen years ago (ab), May, 524
BLADDER
calculi
—solution of phosphatic calculi (with citric acid solution) (ab), Daniel J. Abramson, May, 520
tumors
—consideration of response of bladder tumors to external radiation (ab), Charles C. Herger and Hans R. Sauer, May, 524
BLITZ, DANIEL: Infantile scurvy; case report with follow-up roentgenogram of pre-existent healed scurvy (ab), June, 611
BLOOD
—radioactive phosphate as indicator of relationship between phosphate changes of blood, muscle and liver, following administration of insulin (ab), Nathan O. Kaplan and David M. Greenberg, May, 529
—study with radioactive isotopes of permeability of blood-cerebrospinal fluid barrier to ions (ab), David M. Greenberg, et al, May, 529
BLOOD VESSELS. See Arteries; Veins
BODY SECTION ROENTGENOGRAPHY
—laminagraphy in visualization of suprarenal glands (ab), Seymour F. Wilhelm, March, 309
—mechanism of phonation demonstrated by planigraphy of larynx (ab), Bruno L. Griesman, April, 406
—tomography in region of maxillary sinuses, Ervin H. Holvey and Louis M. Rosenthal, May, 458
BOLEN, H. LEONARD: Byssinosis—report of two cases and review of literature (ab), April, 409
BONES
See also under names of bones
—metabolism of bone salts in resistant rickets; report of case, with balance and radioactive tracer studies (ab), Lewis Gunther, Elma T. Cohn, Waldo E. Cohn, and David M. Greenberg, June, 611
cancer
—plasmocytosis of bone marrow associated with metastatic carcinomatosis (ab), E. Miller, Feb., 209
—"silent" skeletal metastases in cancer (ab), Robert J. Stein, June, 613
cysts. See Bones, tuberculosis; Osteitis fibrosa
diseases
—multiple spontaneous idiopathic symmetrical fractures: Milkman's syndrome (ab), Louis Edeiken and Norman G. Schneeberg, Feb., 207
fractures. See Fractures
fragility. See also Osteosclerosis fragilis
—osteogenesis imperfecta (ab), James F. Brailsford, Feb., 206
growth
—determination of bone age in children; method based on study of 1,129 white children (ab), Louis A. Lurie, Sol Levy, and Max L. Lurie, June, 609
—effect of illness and other factors on appearance pattern of skeletal epiphyses (ab), L. W. Sontag and Janet Lipford, June, 610
—hereditary cleidocranial dysostosis; case, D. D. Salmon, April, 391
—variability in onset of ossification in epiphyses and short bones of the extremities (ab), Idell Pyle and L. W. Sontag, Jan., 98
infarction
—aseptic necrosis in adults; caisson workers and others, Henry K. Taylor, June, 550
marrow
—multiple myeloma first discovered in the mandible; case, Ernest Wolff and Lewis E. Nolan, Jan., 76
—plasmocytosis associated with metastatic carcinomatosis (ab), E. Miller, Feb., 209
—roentgenologic aspects of Ewing's tumor of bone marrow (ab), Paul C. Swenson, April, 417
necrosis. See Bones, infarction
Paget's disease. See Osteitis deformans
pathology
—absorptive bone changes in leprosy, J. P. Cooney and E. H. Crosby, Jan., 14
—bone changes in leprosy; clinical and roentgenologic study of 505 cases, G. H. Faget and A. Mayoral, Jan., 1
tuberculosis
—multiple cystic tuberculosis (ab), F. Ziady and G. Selzer Jan., 99

BONES—*cont.*
tumors. See also Bones, cancer
—osteogenic sarcoma: I. Modified nomenclature and review of 118 five-year cures (ab), Ian Macdonald and John W. Budd, May, 524
—osteoid-osteoma (ed), May, 502
—roentgenologic aspects of Ewing's tumor of bone marrow (ab), Paul C. Swenson, April, 417
—treatment of osteogenic sarcoma with preoperative roentgen radiation in large doses, Robert F. McNattin, March, 246
—x-ray treatment (ab), Charles L. Martin, May, 523
BOOKS RECEIVED (not reviewed)
Bargen, J. Arnold. The Modern Management of Colitis, March, 295
Di Rienzo, S.: Exploración radiológica del bronquio, May, 504
Lex, Jessie K. Metabolism Manual, April, 401
Royal Cancer Hospital (Free) and the Chester Beatty Research Institute. Selected Papers, Jan., 84
BOOKS REVIEWED
Brailsford, James F. Radiology of Bones and Joints, May, 505
de Lorimier, Alfred A. The Arthropathies: A Handbook of Roentgen Diagnosis, Feb., 191
General Electric X-Ray Corporation. Medical Radiographic Technic, Prepared by Members of Technical Service Department, March, 295
Glasser, Otto, editor-in-chief. Medical Physics, June, 600
Glasser, Otto, Quimby, Edith H., Taylor, Lauriston S., and Weatherwax, J. L. Physical Foundations of Radiology, May, 505
Rhinehart, Darmon Artelle. Roentgenographic Technique. A Manual for Physicians, Students, and Technicians, May, 504
Waters, Charles A., Firor, Whitmer B., and Kaplan, Ira I., editors. The 1943 Year Book of Radiology, March, 295
BOON, MARY C. See **McENDY, D. P.**
BORAK, J.: Theories on the effectiveness of roentgen therapy in inflammatory conditions, March, 249
BOWDITCH, MANFRED. See **MORRIS, GEORGE E.**
BOYS, FLOYD, and HARRIS, IVOR D.: Effect of heparinization on experimental post-irradiation tissue changes in the lung: preliminary study (ab), Jan., 104
BRACHYESOPHAGUS (short esophagus). See Esophagus, abnormalities
BRAESTRUP, CARL B.: Depth dose measurements for 100-, 120-, and 135-kv. roentgen rays, March, 258
BRAILSFORD, JAMES F.: Osteogenesis imperfecta (ab), Feb., 206
BRAIN
See also Pituitary Body
abnormalities
—spina bifida and cranium bifidum: Arnold-Chiari malformation: study of 20 cases (ab), Franc D. Ingraham and H. William Scott, Jr., Feb., 196
cysts
—porencephaly (ab), Adolph G. DeSanctis, Martin Green, and Vincent deP. Larkin, June, 604
hernia
—spina bifida and cranium bifidum: unusual nasopharyngeal encephalocele (ab), Franc D. Ingraham and Donald D. Matson, Feb., 196
roentgenography
—contrast media in lesions of the cerebral hemisphere (ab), Edgar A. Kahn, Jan., 90
—electrocardiographic changes during pneumoencephalography (ab), Malcolm W. Bick and Bernard S. Epstein, March, 300
tumors
—motor changes observed fluoroscopically in colon of patient afflicted with tumor in hypothalamic region (ab), A. Mayoral, March, 307
BREAST
cancer
—frequency, clinical course and treatment of metastases from cancer of breast (ab), Jacob R. Freid and Henry Goldberg, May, 522
—pulmonary metastasis and pneumonitis following radiation therapy for cancer of breast (ab), Eugene P. Pendergrass and George White, May, 522
—value of postoperative radiotherapy (ab), R. McWhirter, April, 422
BREZINA, PHILIP S. See **EVELETH, MALCOLM S.**
BRONCHI
cancer
—bronchogenic carcinoma (ab), Foster Murray, April, 408
—roentgen diagnosis of bronchiogenic carcinoma, Harold L. Shinall, March, 213
cysts
—bronchogenic cysts of mediastinum, with report of three cases (ab), W. E. Adams and T. F. Thornton, Jr., March, 302
—roentgenologic appearance of "bronchiogenic" cysts (ab), Laurence L. Robbins, April, 408
diverticula
—diverticulum of right primary bronchus (ab), José Arce, May, 512
tuberculosis
—bronchiectasis secondary to pulmonary tuberculosis (ab), Arnold B. Rilance and Bruno Gerstl, Feb., 200
—tuberculous tracheobronchitis (ab), David McCullough, April, 407
BRONCHIECTASIS
tuberculous
—bronchiectasis secondary to pulmonary tuberculosis (ab), Arnold B. Rilance and Bruno Gerstl, Feb., 200
BROWN, JOHN W., et al: Discussion on atypical pneumonia (ab), Jan., 91
BROWN, R. ALEC. See **PINTO, SHERMAN S.**
BROWN, W. H. See **JENKINSON, E. L.**
BROWN, WEBSTER H. See **SHACKELFORD, RICHARD T.**
BRUCELLA MELITENSIS. See Undulant Fever
BRUCKNER, JOHN P. See **ROTHMAN, MILTON**
BRUNKOW, BEN H.: Uterography; an aid in the diagnosis of gynecological pelvic disorders (ab), May, 517
BRUNN, HAROLD. See **PEARL, FELIX L.**
BRUNNER, HANS, and HARA, H. JAMES: Delayed ossification of the temporal bone (ab), Feb., 205
BRYAN, LLOYD, and PEDERSEN, N. S.: A new gallbladder contrast medium: Priodax, March, 224
BUCKLEY, C. W.: Differential diagnosis of spinal arthritis in young subjects (ab), Feb., 207
BUCY, PAUL C., and SPEIGEL, IRVING J.: An unusual complication of the intraspinal use of iodized oil (ab), April, 420
BUDD, JOHN W. See **MACDONALD, IAN**
BUGBEE, HENRY: Adenoma of the kidney with associated lesions; report of 3 cases (ab), May, 521
BULL, G. M.: Syndrome of atlanto-axial dislocation (ab), Jan., 100
BURNS
—symposium on management of the Cocoanut Grove burns at Massachusetts General Hospital. Roentgenologic report of pulmonary lesions (ab), Richard Schatzki, March, 301
BURSA
—Baker's cyst: posterior herniation of knee joint, Harold H. Kuhn and James E. Hemphill, March, 237
—posterior hernia of knee (Baker's cyst, popliteal cyst, semimembranosus bursitis, medial gastrocnemius bursitis and popliteal bursitis) (ab), Henry W. Meyerding and Robert E. VanDemark, Feb., 208
inflammation
—roentgen treatment of acute bursitis of shoulder (ab), John H. Harris, April, 423
BUSCHKE, FRANZ, and CANTRIL, SIMEON T.: Supervoltage roentgen therapy of esophageal carcinoma, May, 480
BYARS, LOUIS T.: The "malignant" hemangioma (ab), March, 315
BYSSINOSIS
—report of two cases and review of literature (ab), H. Leonard Bolen, April, 409

C

CAISSON DISEASE
—aseptic necrosis in adults: caisson workers and others, Henry K. Taylor, June, 550
CALCIFICATION
See also Heart, calcification
—determination of the position of calcium deposits and foreign bodies from stereoscopic films without the use of a viewing stereoscope, Sam Levi, Jan., 71
CALLUS
—roentgenologic manifestations of bone repair; healing of fractures without external callus (ab), Robert G. Vance and George M. Wyatt, March, 310
CAMIEL, MORTIMER R., and BERKAN, HENRY S.: Inhalation pneumonia from nitric fumes, Feb., 175
——See **RENDICH, RICHARD A.**
CAMP, JOHN D., and NASH, LEO A.: Developmental thinness of the parietal bones, Jan., 42
CAMPBELL, EDGAR T.: Primary atypical pneumonia and malaria (ab), April, 408
CAMPBELL, THOMAS A., STRONG, PAUL S., GRIER, GEORGE S., III, and LUTZ, R. J.: Primary atypical pneumonia: report of 200 cases at Fort Eustis, Virginia (ab), Feb., 197
CANAVAN, MYRTELLE M.: Anomalous origins of the posterior intercostal arteries from 915 thoracic aortas: their role in fractures of the ribs (ab), May, 513
CANCER
See also Sarcoma; Tumors; and under organs and regions
—place of National Cancer Institute in cancer program, R. R. Spencer, May, 493
in infants and children
—primary liver-cell carcinoma in infancy; two cases, one showing calcification (ab), Wray J. Tomlinson and Ernst Wolff, April, 416
metastases. See also Bones, cancer; Lungs, cancer; Lymph Nodes, cancer
—accidental trauma and tumor metastases, Benedict J. Toth, June, 579
—bilateral carcinoma of adrenal cortex with metastasis to iliac bone (ab), Mather Cleveland and Leila C. Knox, March, 309
—carcinoid tumors (so-called) of ileum; report of 13 cases in which there was metastasis (ab), Malcolm B. Dockerty and Frank S. Ashburn, April, 415
—frequency, clinical course and treatment of metastases from cancer of breast (ab), Jacob R. Freid and Henry Goldberg, May, 522
—results of roentgen therapy for metastatic neoplasms (ab), W. G. Deucher, March, 316

CANCER—*cont.*
multiple
—clinical picture, diagnosis and prognosis (ab), Hugo Hellendall, May, 524
—multiple primary malignant lesions; 2 case reports (ab), Heinrich L. Wehrbein and John J. Weber, April, 423
therapy
—castration in malignant and non-malignant disease, Benjamin H. Orndoff, Feb., 159
CANTRIL, SIMEON T. See **BUSCHKE, FRANZ**
CARDIA. See Stomach, cardiospasm
CARDIOSPASM. See Stomach, cardiospasm
CARDIOVASCULAR SYSTEM
See also Arteries; Heart; Veins
roentgenography
—angiocardiography in congenital heart disease: intracardiac shunts (ab), M. F. Steinberg, A. Grishman, and M. L. Sussman, Jan., 93
—angiocardiography in congenital heart disease: patent ductus arteriosus (ab), M. F. Steinberg, A. Grishman, and M. L. Sussman, April, 411
CARLILE, THOMAS. See **BAKER, JOEL W.**
CARLTON, B. HARDY. See **PINTO, SHERMAN S.**
CARSON, WILLIAM J.: Trauma and malignancy (ab), March, 314
CARTILAGE
transplantation
—osteitis fibrosa cystica: differential diagnosis, with note on repair of maxillary lesion by cartilaginous isograft (ab), Noah Fox and Vito Taglia, April, 418
CASPER, STEPHEN L.: Sigmoiditis (ab), Feb., 203
CASTRATION
—in malignant and non-maligant disease, Benjamin H. Orndoff, Feb., 159
CAVE, PAUL: Precision method of cephalometry and pelvimetry (ab), March, 312
CECUM
diverticula
—solitary diverticulitis (ab), Joel W. Baker and Thomas Carlile, Jan., 97
volvulus. See Intestines, volvulus
CEPHALOMETRY. See Craniometry
CEREBROSPINAL FLUID
—study with radioactive isotopes of permeability of blood-cerebrospinal fluid barrier to ions (ab), David M. Greenberg, et al, May, 529
CETRULO, GERALD I. See **CRECCA, WILLIAM D.**
CHAIKOFF, I. L. See **MONTGOMERY, M. LAURENCE**
CHAMBERLIN, GEORGE W., and PAYNE, FRANKLIN L.: Urinary tract changes with benign pelvic tumors, Feb. 117
CHARACHE, HERMAN: Primary lymphosarcoma of the intestine in a boy of seven. Follow-up of nine years (ab), March, 317
CHARCOT JOINTS. See Hip, diseases
CHARTERIS, ALEXANDER A.: Local application of sulphanilamide powder in radiotherapy (ab), June, 615
CHEST. See Thorax
CHILDREN
See also Infants
—angiocardiography in congenital heart disease: intracardiac shunts (ab), M. F. Steinberg, A. Grishman, and M. L. Sussman, Jan., 93
—angiocardiography in congenital heart disease: patent ductus arteriosus (ab), M. F. Steinberg, A. Grishman, and M. L. Sussman, April, 411
—Cushing's syndrome in children. Review of literature and report of case (ab), Jason E. Farber, Francis J. Gustina, and Anthony V. Postoloff, April, 416
—determination of bone age in children; method based on study of 1,129 white children (ab), Louis A. Lurie, Sol Levy, and Max L. Lurie, June, 609
—effect of illness and other factors on appearance pattern of skeletal epiphyses (ab), Lester W. Sontag and Janet Lipford, June, 610
—feet of normal children; study of lateral x-rays of weight-bearing foot (ab), Meinhard Robinow, Margaret Johnston, and Margaret Anderson, June, 610
—foreign bodies in the air passages of children (ab), P. M. Frederick and J. G. Verberkmoes, March, 301
—hemangioma of elbow successfully treated with radium at early age (ab), Ira I. Kaplan, April, 423
—infantile scurvy; case report with follow-up roentgenogram of pre-existent healed scurvy (ab), Daniel Blitz, June, 611
—juvenile elongation of the aorta (ab), F. Y. Khoo, March, 306
—metabolism of bone salts in resistant rickets: report of case, with balance and radioactive tracer studies (ab), Lewis Gunther, Elma T. Cohn, Waldo E. Cohn, and David M. Greenberg, June, 611
—nontuberculous empyema thoracis in children (ab), J. K. Berman, Jan., 91
—obstructive emphysema and atelectasis in tuberculosis of infants and children (ab), Julio Meneghello and Clement A. Smith, June, 604
—perinephric abscess in infants and children; a study of 26 patients surgically treated (ab), Henry Swan, April, 420
—primary lymphosarcoma of intestine in boy of seven. Follow-up of nine years (ab), Herman Charache, March, 317
—pulmonary manifestations following ingestion of kerosene (ab), Leonard I. Lesser, H. Stephen Weens, and John D. McKey, June, 605
—radioactive iodine studies in childhood hypothyroidism (ab), Joseph G. Hamilton, Mayo H. Soley, William A. Reilly, and Karl B. Eichorn, June, 604
—renal dwarfism or renal rickets (ab), Robert C. Moehlig, June, 612
—similarity of clinical and roentgen findings in children with Ewing's sarcoma (endothelial myeloma) and sympathetic neuroblastoma (ab), Robert P. Barden, June, 612
—variability in onset of ossification in epiphyses and short bones of extremities (ab), Idell Pyle and L. W. Sontag, Jan., 98
CHILDRESS, H. M.: March fracture of the lower extremity. Report of a case of march fracture of a cuneiform bone (ab), March, 311
CHLOROPHYLL OINTMENT
—treatment of post-irradiation erythema with chlorophyll ointment (ab), George W. Holmes and H. Peter Mueller, March, 318
CHOLECYSTOGRAPHY. See Gallbladder, roentgenography
CHOLELITHIASIS. See Gallbladder, calculi
CHONT, L. K.: Adamantinoma: report of 8 cases (ab), May, 511
CLARK, L. H., and JONES, D. E. A.: Some results of photographic estimation of stray x radiation received by hospital x-ray personnel (ab), April, 424
CLARKSON, WRIGHT (obit), March, 293
CLEIODOCRANIAL DYSOSTOSIS. See Dysostosis
CLEVELAND, MATHER, and KNOX, LEILA C.: Bilateral carcinoma of the adrenal cortex with metastasis to the iliac bone (ab), March, 309
COAKLEY, WALTER A., and WHITE, MALVIN F.: Fractures of the zygoma; report of 72 consecutive cases (ab), May, 510
COBEY, MILTON C.: Osteochondritis dissecans of the astragalus (ab), May, 517
COHN, ALLAN L., and LEVITIN, JOSEPH: Problems in gastric diagnosis: the gastroscope as a supplementary aid to x-ray examination (ab), May, 513
COHN, ELMA T. See **GUNTHER, LEWIS**
COHN, WALDO E. See **GUNTHER, LEWIS**
COLE, LEWIS GREGORY: Foreign body localization and extraction. Description of a method more accurate than that used by the Army (ab), May, 521
COLLER, FREDERICK A., and JACKSON, RICHARD G.: Anterior sacral meningocele (ab), Jan., 99
COLON
—lateral view in roentgenologic diagnosis of lesions (ab), Egon G. Wissing and Robert M. Lowman, Feb., 203
—motor changes observed fluoroscopically in colon of patient afflicted with a tumor in the hypothalmic region (ab), A. Mayoral, March, 307
cancer
—clinical features, diagnosis, and treatment of carcinoma of colon and rectum, David S. Beilin, June, 539
—roentgenologic diagnosis of carcinoma (ab), L. W. Baird, March, 307
dilatation
—dyschezia and megacolon, Arthur Hurst, Feb., 128. See communication, Percy J. Delano, Feb., 190
volvulus. See Intestines, volvulus
COLP, RALPH. See **YARNIS, HARRY**
CONNOR, GERVASE J.: Left subdiaphragmatic abscess: report of case (ab), March, 309
CONTRACTURE
Dupuytren's
—as sequel to coronary artery disease and myocardial infarction (ab), Kenneth C. Kehl, March, 311
COONEY, J. P., and CROSBY, E. H.: Absorptive bone changes in leprosy, Jan., 14
COOPER, WILLIAM GRANT, Jr. See **LeMONE, DAVID V.**
COR PULMONALE. See Heart, dilatation
CORAY, Q. B. See **HICKEN, N. FREDERICK**
CORONARY VESSELS
occlusion
—Dupuytren's contracture as sequel to coronary artery disease and myocardial infarction (ab), Kenneth C. Kehl, March, 311
CORONOID PROCESS. See Jaws
COWIE, DEAN B. See **DOWDY, ANDREW H.**
CRANIOMETRY
—precision method of cephalometry and pelvimetry (ab), Paul Cave, March, 312
—roentgenographic obstetrical pelvicephalometry in the erect posture (ab), Robert P. Ball and Ross Golden, Jan., 101
CRANIUM
See also Craniometry
—developmental thinness of the parietal bones, John D. Camp and Leo A. Nash, Jan., 42
—identification of skulls by x-ray picture of frontal sinuses (ab), Arthur Schuller, Feb., 196
—spina bifida and cranium bifidum: Arnold-Chiari malformation: study of 20 cases (ab), Franc D. Ingraham and H. William Scott, Jr., Feb., 196
—spina bifida and cranium bifidum: unusual nasopharyngeal encephalocele (ab), Franc D. Ingraham and Donald D. Matson, Feb., 196
diseases
—pitfalls to be avoided in the roentgen diagnosis of intracranial disease, Charles W. Schwartz, Jan., 34

CRANIUM—*cont.*
fractures
—notes on radiography of head injuries (ab), E. W. Frecker, March, 300
tuberculosis
—of flat bones of vault: study of 40 cases (ab), C. M. Meng and Y. K. Wu, May, 510
CRAWFORD, J. HAMILTON. See **HOLLANDER, A. GERSON**
CRECCA, WILLIAM D., and CETRULO, GERALD I.: Improved technic for blind nailing of the neck of the femur. The Crecca-Cetrulo guide (ab), April, 418
CRECCA-CETRULO GUIDE
—improved technic for blind nailing of neck of femur; Crecca-Cetrulo guide (ab), William D. Crecca and Gerald I. Cetrulo, April, 418
CREEVY, C. D. See **BIXLER, LOUIS C.**
CRILLY, JAMES A. See **KRAUSE, GEORGE R.**
CROSBY, E. H. See **COONEY, J. P.**
CULVER, HARRY. See **KIRSHBAUM, JACK D.**
CUMULATIVE INDEX (Radiology) (ed), Jan., 83
CUNEIFORM BONE. See Foot
CURRAN, E. J. See **TICE, GALEN M.**
CURRENS, JAMES H., and POPP, WALTER C.: Xanthomatosis—Hand-Schüller-Christian type: report of a case with pulmonary fibrosis (ab), Jan., 92
CURTISS, L. F.: Prevention and control of hazards in the radium dial painting industry (ab), March, 318
CUSHING'S SYNDROME. See Pituitary Body, diseases
CYSTS. See Lungs, cysts; Mediastinum, cysts; Omentum, cysts; etc.

D

DALE, WALTER M.: Effect of x-rays on aqueous solutions of biologically active compounds (ab), April, 424
DANDY, WALTER E.: Recent advances in the treatment of ruptured (lumbar) intervertebral disks (ab), May, 515
DAVIDSON, CHARLES N. See **WALTON, HENRY J.**
DAVIS, ARTHUR G.: Pin distraction as the cause of non-union (ab), Feb., 209
DEAFNESS
—use of radium in conduction deafness (ab), Gilbert E. Fisher, March, 317
DeANGELIS, EUGENE: Dissecting aneurysm of the abdominal aorta (ab), March, 306
DeBAKEY, M. E., SCHROEDER, G. F., and OCHSNER, A.: Significance of phlebography in phlebothrombosis (ab), June, 614
DEERY, EDWIN M.: Herniation of the nucleus pulposus as a complication of pre-existing low back instability (ab), Feb., 208
DEFECATION
—dyschezia and megacolon, Arthur Hurst, Feb., 128. See communication, Percy J. Delano, Feb., 190
DEGLUTITION
disorders
—treatment of dysphagia from hernia through esophageal hiatus in diaphragm (ab), Porter P. Vinson, April, 412
DEMING, CLYDE L.: Ureteropelvic obstruction due to extrinsic and intrinsic lesions of ureter as clinical entity and its treatment (ab), June, 613
DEMPSEY, MARY (editor): Statistical data. New cases of tuberculosis discovered by case-finding surveys (ab), Feb., 198
DeSANCTIS, ADOLPH G., GREEN, MARTIN, and LARKIN, VINCENT deP.: Porencephaly (ab), June, 604
DEUCHER, W. G.: Results of roentgen therapy for met..static neoplasms (ab), March, 316
DEWEESE, E. R., and HOWARD, JOHN C., Jr.: Congenital absence of a lung: diagnosed before death, April, 389
DEXTROCARDIA. See Heart, displacements
DIAPHRAGM
hernia. See Hernia, diaphragmatic
DIGESTIVE SYSTEM. See Cecum; Colon; Duodenum; Esophagus; Intestines; Rectum; Stomach
DINGLE, JOHN H., et al: Primary atypical pneumonia, etiology unknown (ab), April, 407
DIVERTICULA. See Cecum, diverticula; Intestines, diverticula
DIX, C. R. See **FIGI, F. A.**
DIXON, CLAUDE F. See **BENSON, RAYMOND E.**
DOBELLE, MARTIN: Brucella spondylitis; case report (ab), May, 516
DOCKERTY, MALCOLM B., and ASHBURN, FRANK S.: Carcinoid tumors (so-called) of the ileum: report of 13 cases in which there was metastasis (ab), April, 415
——See **WEISEL, WILSON**
DONOVAN, MARK S., NEUHAUSER, EDWARD B. D., and SOSMAN, MERRILL C.: Roentgen signs of patent ductus arteriosus: summary of 50 surgically verified cases (ab), April, 411
DOOLEY, SAMUEL W. See **OLCOTT, CHARLES T.**
DOWDY, ANDREW H., DuBILIER, BENJAMIN, and COWIE, DEAN B.: New type of radium loading protective device (ab), Jan., 104
DuBILIER, BENJAMIN. See **DOWDY, ANDREW H.**
DUCTUS ARTERIOSUS
—angiocardiography in congenital heart disease. Patent ductus arteriosus (ab), M. F. Steinberg, A. Grishman, and M. L. Sussman, April, 411
—roentgen signs of patent ductus arteriosus: summary of 50 surgically verified cases (ab), Mark S. Donovan, Edward B. D. Neuhauser, and Merrill C. Sosman, April, 411
DUODENUM
—deformities of duodenum other than those due to ulcer (ab), John T. Farrell, Jr., March, 306
—elimination of administered zinc in pancreatic juice, duodenal juice, and bile of dog as measured by its active isotope (Zn^{65}) (ab), M. Laurence Montgomery, G. E. Sheline, and I. L. Chaikoff, May, 529
cysts
—enterogenous cyst (ab), Richard Orgias, Feb., 202
ulcers. See Peptic Ulcer
DUPUYTREN'S CONTRACTURE. See Contracture
DUST. See Pneumoconiosis
DWARFISM
—renal dwarfism or renal rickets (ab), Robert C. Moehlig, June, 612
DWYER, MAURICE F. (obit), June, 599
DYKE, CORNELIUS G. See **BELANGER, W. GEORGE**
DYSCHEZIA
—dyschezia and megacolon, Arthur Hurst, Feb., 128. See communication, Percy J. Delano, Feb., 190
DYSOSTOSIS
—hereditary cleidocranial dysostosis; case, D. D. Salmon, April, 391
DYSPEPSIA
—peptic ulcers and dyspepsia in the Army (ab), Henry Tidy, June, 607
DYSPHAGIA. See Deglutition, disorders
DYSTOCIA. See Labor, complications

E

EAR
See also Deafness
tumors
—malignant tumors of middle ear and mastoid process (ab), Frederick A. Figi and Bert E. Hempstead, April, 420
EATON, MONROE D.: Virus pneumonia: etiological studies (ab), April, 407
ECONOMICS, MEDICAL
—political realism (ed), Sydney J. Hawley, June, 597
EDDLEMAN, THOMAS S. See **TERHUNE, SAMUEL R.**
EDEIKEN, LOUIS, and SCHNEEBERG, NORMAN G.: Multiple spontaneous idiopathic symmetrical fractures: Milkman's syndrome (ab), Feb., 207
EDITORIALS
announcing a joint meeting of the Radiological Society of North America and American Roentgen Ray Society, March, 289
congenital dislocation of the hip, Feb., 188
Cumulative Index (Radiology), Jan., 83
"fatigue" fracture or "march" fracture, April, 397
osteoid-osteoma, May, 502
political realism, Sydney J. Hawley, June, 597
presidential address; Twenty-ninth Annual Meeting of Radiological Society of North America, Robert S. Stone, March, 290
Witwer, Eldwin Roy, Jan., 81
EHRENHAFT, J. L.: Development of the vertebral column as related to certain congenital and pathological changes (ab), Jan., 98
EHRLICH, DAVID E.: Aortic arch and cardiac mensuration, April, 382
EICHORN, KARL B. See **HAMILTON, JOSEPH G.**
EISEN, DAVID: Right aortic arch, with report of eight cases, June, 570
ELBOW
tumors
—hemangioma successfully treated with radium at early age (ab), Ira I. Kaplan, April, 423
ELECTROCARDIOGRAPHY. See Heart, electrocardiography
EMPHYSEMA
pulmonary
—obstructive emphysema and atelectasis in tuberculosis of infants and children (ab), Julio Meneghello and Clement A. Smith, June, 604
EMPYEMA
—nontuberculous empyema thoracis in children (ab), J. K. Berman, Jan., 91
ENCEPHALITIS
—fatal case of atypical pneumonia with encephalitis (ab), Hector Perrone and Myron Wright, Feb., 198
ENCEPHALOCELE. Se Brain, hernia
ENCEPHALOGRAPHY. See Brain, roentgenography
ENDOMETRIOSIS
—study of 117 cases, with special reference to constricting lesions of rectum and sigmoid colon (ab), E. L. Jenkinson and W. H. Brown, Jan., 97
ENGELN, HENRY P. (obit), April, 400
ENGLE, D.: Etiology of the undescended scapula and related syndromes (ab), Feb., 205
ENGLER, CLARENCE W.: Roentgen therapy of laryngeal tuberculosis (ab), May, 525
EOSINOPHILS
—eosinophilic granuloma of tibia; case (ab), Thomas Horwitz, April, 418
—Loeffler's syndrome; case (ab), James H. Smith, Jan., 91
—solitary eosinophilic granuloma (of femur); case (ab), Graham A. Kerawein and Frank B. Queen, Feb., 209
EPIPHYSES
—case of Ewing tumor of right femur, in epiphysis, with unusual pathologic fracture (ab), Guillermo Halley, Jan., 103

EPIPHYSES—*cont.*
—determination of bone age in children; method based on study of 1,129 white children (ab), Louis A. Lurie, Sol Levy, and Max L. Lurie, June, 609
—effect of illness and other factors on appearance pattern of skeletal epiphyses (ab), L. W. Sontag and Janet Lipford, June, 610
—variability in onset of ossification in epiphyses and short bones of extremities (ab), Idell Pyle and L. W. Sontag, Jan., 98
EPSTEIN, BERNARD S.: Early radiologic recognition of mitral valve disease (ab), June, 607
——See **BICK, MALCOLM W.**
——and **KULICK, MAX:** Technic for optic foramen roentgenography, Feb., 186
ERF, LOWELL A., and JONES, HAROLD W.: Radio-phosphorus: an agent for the satisfactory treatment of polycythemia and its associated manifestations; report of a case of polycythemia secondary possibly to Banti's syndrome (ab), May, 526
ERLANGER, HERMAN, and LEVINE, SAMUEL A.: Atrial septal defect: report of two cases in which there was recurrent laryngeal nerve paralysis (ab) May, 513
ERYTHEMA
—treatment of post-irradiation erythema with chlorophyll ointment (ab), George W. Holmes and H. Peter Mueller, March, 318
ERYTHROBLASTOSIS. See Anemia, erythroblastic
ESOPHAGUS
See also Deglutition
abnormalities
—short esophagus with simple peptic ulceration (ab), P. R. Allison, A. S. Johnstone, and G. B. Royce, Jan., 94
atresia
—congenital atresia with tracheoesophageal fistula; extrapleural ligation of fistula and end-to-end anastomosis of esophageal segments (ab), Cameron Haight and Harry A. Towsley, Jan., 94
cancer
—in association with achalasia of cardia, S. R. Bersack, March, 220
—radiation therapy; analysis of 85 cases observed during last decade (ab), Ernst A. Pohle and Roland R. Benson, Feb., 210
—supervoltage roentgen therapy, Franz Buschke and Simeon T. Cantril, May, 480
ulcers
—short esophagus with simple peptic ulceration (ab), P. R. Allison, A. S. Johnstone, and G. B. Royce, Jan., 94
ESSENBERG, J. M. See **MOMIGLIANO, EMANUELE**
ETTINGER, ALICE: Layer formation in pyelography (ab), Jan., 102
EUSTACHIAN TUBE
—primary carcinoma: study of evidence of its occurrence (ab), Lawrence J. Lawson, Feb., 211
—recognition and radium treatment of infected and hypertrophied lymphoid tissue in nasopharynx; preliminary report (ab), Gilbert E. Fisher, March, 317
—use of radium (to irradiate lymphoid tissue around tube) in conduction deafness (ab), Gilbert E. Fisher, March, 317
EVANS, ROBLEY D.: Protection of radium dial workers and radiologists from injury by radium (ab), March, 318
——See **HEMEON, W. C. L.**
——See **WILLIAMS, CHARLES R.**
EVELETH, MALCOLM S., and BREZINA, PHILIP S.: Synovioma involving the knee joint: case report (ab), May, 516
EWING TUMORS. See Tumors, Ewing's
EXTREMITIES. See Legs
EYES. See Retina

F

FAGET, G. H., and MAYORAL, A.: Bone changes in leprosy: a clinical and roentgenologic study of 505 cases, Jan., 1
FALLOPIAN TUBES
roentgenography
—visualization (ab), Jason H. Robberson, May, 518
FALLOT'S TETRALOGY. See Heart, abnormalities
FARBER, JASON E., GUSTINA, FRANCIS J., and POSTOLOFF, ANTHONY V.: Cushing's syndrome in children; review of literature and report of case (ab), April, 416
FARKAS, ALADÁR: Paralytic scoliosis (ab), Feb., 207
FARRELL, JOHN T., Jr.: Deformities of the duodenum other than those due to ulcer (ab), March, 306
FAT
—fat meal—its value in cholecystography (ab), Ralph D. Bacon, June, 609
FAUST, DANIEL B., and MUDGETT, CHAS. S.: Visualization of the biliary tract with air and barium following a barium meal (ab), March, 308
FECES. See Defecation
FEIGIN, IRWIN, and ROSENTHAL, JULIUS: Tetralogy of Fallot (ab), April, 412
FELDMAN, MAURICE: Responsibility of the roentgenologist in the wartime duodenal ulcer problem, April, 356
FEMUR
See also Hip
blood supply
—evolution of circulation in developing femoral head and neck; anatomic study (ab), W. Eugene Wolcott, Feb., 204
diseases
—solitary eosinophilic granuloma; case (ab), Graham A. Kernwein and Frank B. Queen, Feb., 209
fractures
—improved technic for blind nailing of neck of femur; Crecca-Cetrulo guide (ab), William D. Crecca and Gerald I. Cetrulo, April, 418
tumors
—Ewing tumor of right femur, in epiphysis, with unusual pathological fracture (ab), Guillermo Halley, Jan., 103
—giant-cell tumor of the lower femur. Case report with roentgen and pathological findings before and after curettage and roentgen therapy with amputation for sarcoma, F. B. Mandeville and John S. Howe, Jan., 56
FETTER, FERDINAND: Carcinoma of the lung. Review of 31 proved cases at the Philadelphia Naval Hospital (ab), Jan., 92
FETUS
—roentgen study of fetus in utero: some practical considerations, William Snow and Milton Nadel, Feb., 136
FIBROMA. See Tumors, fibroma
FIBULA
fractures
—ice skater's fracture; a form of fatigue fracture (ab), C. F. Ingersoll, May, 515
FIGI, FREDERICK A., and HEMPSTEAD, BERT E.: Malignant tumors of the middle ear and mastoid process (ab), April, 420
——**NEW, G. B., and DIX, C. R.:** Radiodermatitis of the head and neck with a discussion of its surgical treatment (ab), May, 527
FIGUERAS GONZÁLES, W. See **PUENTE DUANY, N.**
FILMS. See Roentgen Rays, films
FINGERS AND TOES
—disabling changes in hands resembling sclerodactylia following myocardial infarction (ab), Alf C. Johnson, April, 419
abnormalities
—congenital aneurysmal dilatation of the aorta associated with arachnodactyly (ab), Ridgely W. Baer, Helen B. Taussig, and Ella H. Oppenheimer, March, 305
—symphalangism, a familial malformation (ab), Paul Freud and Lawrence B. Slobody, April, 417
FISHER, GILBERT E.: Recognition and radium treatment of infected and hypertrophied lymphoid tissue in the nasopharynx: preliminary report (ab), March, 317
Use of radium in conduction deafness (ab), March, 317
FISTULA
appendicocolic
—case (ab), Louis P. River and Billens C. Gradinger, April, 415
arteriovenous
—use of venograms for localization and study of arteriovenous fistula (ab), James R. Watson, J. M. Lichty, J. M. Hill, and R. B. Miller, Jan., 102
esophagotracheal
—congenital atresia of esophagus with tracheoesophageal fistula; extrapleural ligation of fistula and end-to-end anastomosis of esophageal segments (ab), Cameron Haight and Harry A. Towsley, Jan., 94
FLOOD, CHARLES A.: Peptic ulcer at Fort George G. Meade, Md., April, 412
FLUOROSCOPY. See Roentgen Rays, fluoroscopy
FLYNN, JAMES M.: Erythroblastic anaemia with review of literature (ab), April, 424
FOCHT, ELIZABETH F. See **QUIMBY, EDITH H.**
FOOT
See also Ankle; Metatarsus
—feet of normal children; study of lateral x-rays of weight-bearing foot (ab), Meinhard Robinow, Margaret Johnston, and Margaret Anderson, June, 610
fractures
—march fractures of lower extremity. Case of march fracture of cuneiform bone (ab), H. M. Childress, March, 311
FORAMEN
—technic for optic foramen roentgenography, Bernard S. Epstein and Max Kulick, Feb., 186
FORBES, G. B. See **SALMON, G. W.**
FOREIGN BODIES
—adaptor for fluoroscopic depth localization (ab), Leo Mackta, May, 521
—determination of the position of calcium deposits and foreign bodies from stereoscopic films without the use of a viewing stereoscope, Sam Levi, Jan., 71
—foreign body (bottle) in rectum; case, Stanley H. Macht, May, 500
—foreign body localization and extraction; description of method more accurate than that used by the Army (ab), Lewis G. Cole, May, 521
—in air passages of children (ab), P. M. Frederick and J. G. Verberkmoes, March, 301
FOX, NOAH, and TAGLIA, VITO: Osteitis fibrosa cystica: differential diagnosis, with note on repair of maxillary lesion by cartilaginous isograft (ab), April, 418
FRACTURES
See also under names of bones
—"fatigue" fracture or "march" fracture (ed), April, 397
—ice skater's fracture; a form of fatigue fracture (ab), C. F. Ingersoll, May, 515
—march fracture or insufficiency fracture (ab), Samuel H. Nickerson, June, 611
—multiple spontaneous idiopathic symmetrical fractures: Milkman's syndrome (ab), Louis Edeiken and Norman G. Schneeberg, Feb., 207

FRACTURES—*cont.*
—roentgenologic manifestations of bone repair. Healing of fractures without external callus (ab), Robert G. Vance and George M. Wyatt, March, 310
FRASER, KENNETH: Intussusception of the appendix (ab), Feb., 203
FRAZER, MAURICE D. See **ROWE, EDWARD W.**
FRECKER, E. W.: Notes on the radiography of head injuries (ab), March, 300
FREDERICK, P. M., and VERBERKMOES, J. G.: Foreign bodies in the air passages of children (ab), March, 301
FREEDMAN, EUGENE, and MESCHAN, I.: Syphilitic spondylitis (ab), Jan., 99
FREI, C.: Results of systematic fluoroscopy of an Army Unit on relief from service (ab), Jan., 90
FREID, JACOB R., and GOLDBERG, HENRY: Frequency, clinical course and treatment of metastases from cancer of the breast (ab), May, 522
FREUD, PAUL, and SLOBODY, LAWRENCE B.: Symphalangism, a familial malformation (ab), April, 417
FRIEDEWALD, WM. F., and ANDERSON, RUBERT S.: Effects of roentgen rays on cell-virus associations. Findings with virus-induced rabbit papillomas and fibromas (ab), May, 529
FRONTAL SINUS
—identification of skulls by x-ray pictures of frontal sinuses (ab), Arthur Schuller, Feb., 196
tumors
—osteoma; case (ab), W. H. Johnston, May, 511
FUCHS, ARTHUR W.: Optimum kilovoltage technique in military roentgenography (ab), May, 522
FURTH, JACOB. See **McENDY, D. P.**

G

GALLBLADDER
calculi
—gallstone ileus; recurrence in 1 case (ab), B. Hollis Hand and William E. Gilmore, March, 307
—intestinal obstruction due to gallstone (ab), Robert L. Nitkin and Albert Lesser, March, 308
—significance and accuracy of cholecystographic findings (ab), A. M. Serby and Gemma M. Lichtenstein, March, 308
perforation
—twenty-four cases (ab), N. Frederick Hicken and Q. B. Coray, March, 308
roentgenography. See also Biliary Tract, roentgenography
—cholecystography with Priodax: report on 600 examinations, H. W. Hefke, March, 233
—correlation of roentgenological, surgical, and medical findings in 355 cases (ab), Henry J. Walton and Charles N. Davidson, Feb., 204
—fat meal—its value in cholecystography (ab), Ralph D. Bacon, June, 609
—new contrast medium: Priodax, Lloyd Bryan and N. S. Pedersen, March, 224
—oral cholecystography; comparative study of single- and divided-dose method with contrast media in liquid and solid form, L. W. Paul and E. A. Pohle, with collaboration of R. R. Benson, March, 226
GALLSTONES. See Gallbladder, calculi
GALLUCCIO, A. C.: Spondylolisthesis: a general consideration with emphasis on radiologic aspects, Feb., 143
GARBER, A. ELIZABETH. See **THOMAS, M. E.**
GARBER, ROBERT L.: Isolated fracture of the first rib produced by muscular traction, April, 395
Rhabdomyosarcoma of the extremities, June, 595
GARCIA, MANUEL, and MENVILLE, LEON J.: Treatment of carcinoma of cervix at Charity Hospital: preliminary report of end results (ab), April, 423
GÁRCIGA, CARLOS E.: Therapeutic abortion by x-rays (ab), Jan., 104
GARGOYLISM
—report of three probable cases (ab), Sidney Larson and John A. Lichty, Jr., Feb., 206
GASTON, EUGENE A., and WARREN, LYMAN O.: Supralevator abscess (ab), May, 514
GASTRIC ULCER. See Peptic Ulcer
GASTROENTEROLOGY. See Gastro-Intestinal Tract, diseases
GASTRO-INTESTINAL TRACT
See also Cecum; Colon; Intestines; Rectum; Stomach
diseases
—diagnostic roentgenology in gastro-enterology for the year 1941 (ab), Frank J. Rigos and B. R. Kirklin, April, 416
—review of gastro-enterologic diagnostic roentgenologic literature for the year 1942 (ab), Frank J. Rigos and B. R. Kirklin, April, 416
GASTROSCOPY. See Stomach, gastroscopy
GEDGOUD, JOHN L.: Diagnosis of virus pneumonitis in infancy (ab), Feb., 198
GEEVER, ERVING F.: Miliary calcification of the lung (ab), Jan., 90
GENITALS
tuberculosis
—roentgen therapy of pelvic tuberculosis in the female, Harriet C. McIntosh, Jan., 48
tumors
—urinary tract changes with benign pelvic tumors, George W. Chamberlin and Franklin L. Payne, Feb., 117
GENITO-URINARY TRACT. See Genitals; Kidneys; Ureters; Urethra; etc.
GERSTL, BRUNO. See **RILANCE, ARNOLD B.**
GHORMLEY, RALPH K. See **PHALEN, GEORGE S.**
GILMORE, WILLIAM E. See **HAND, B. HOLLIS**
GLIOMA. See Retina, tumors
GOIN, LOWELL S.: Low-voltage contact irradiation therapy: further experience, March, 241
GOLDBERG, HENRY. See **FREID, JACOB R.**
GOLDEN, ROSS: Enlargement of the ileocecal valve (ab), Feb., 203
——See **BALL, ROBT. P.**
GOLDMAN, ALFRED: Cavernous hemangioma of the lung: secondary polycythemia (ab), June, 606
GOLDMAN, DOUGLAS: Metabolic changes occurring as the result of deep roentgen therapy: I. Effect of 200 kilovolt roentgen therapy (ab), May, 527
GOLDMAN, LEON: Intestinal strangulating obstruction with negative roentgenologic findings (ab), Jan., 96
GOLDNER, MARTIN. See **UHLMANN, ERICH M.**
GOLTZ, H. L. See **REINHARD, M. C.**
GONADS
See also Ovary; Testes
—regenerative processes induced by gonadotropic hormones in irradiated testes of albino rat, Emanuele Momigliano and J. M. Essenberg, March, 273
GONZALES-IMAN, FERNAN: Retrograde seminal vesiculography (ab), March, 313
GOOD, C. ALLEN: Entero-enteric intussusception, Feb., 122
GRADINGER, BILLENS C. See **RIVER, LOUIS P.**
GRANULOMA
—eosinophilic granuloma of tibia; case (ab), Thomas Horwitz, April, 418
—solitary eosinophilic granuloma (of femur); case (ab), Graham A. Kernwein and Frank B. Queen, Feb., 209
GREEN, MARTIN. See **DeSANCTIS, ADOLPH G.**
GREENBERG, DAVID M., et al: Study with radioactive isotopes of the permeability of the blood-cerebrospinal barrier to ions (ab), May, 529
——See **GUNTHER, LEWIS**
——See **KAPLAN, NATHAN O.**
GREENBERG, ROSE. See **MAZER, CHARLES**
GREENFIELD, IRVING, STEINBERG, ISRAEL, and TOUROFF, ARTHUR S. W.: "Spring water" cyst of the mediastinum: case report (ab), Jan., 93
GRIER, GEORGE S., III. See **CAMPBELL, THOMAS A.**
GRIESMAN, BRUNO L.: Mechanism of phonation demonstrated by planigraphy of the larynx (ab), April, 406
GRISHMAN, A. See **STEINBERG, M. F.**
——See **SUSSMAN, M. L.**
GROH, J. A.: Mono-osteitic Paget's disease as a clinical entity: roentgenologic observations in 9 cases (ab), March, 310
GROSJEAN, ANDRÉ: Lymphogranulomatosis and tuberculosis (ab), March, 316
GUNTHER, LEWIS, COHN, ELMA T., COHN, WALDO E., and GREENBERG, DAVID M.: Metabolism of bone salts in resistant rickets; report of case, with balance and radioactive tracer studies (ab), June, 611
GUSTINA, FRANCIS J. See **FARBER, JASON E.**

H

HÄUPTLI, O.: Carcinoma of the large bowel, excepting the rectum (ab), Jan., 97
HAHN, G. A. See **SCHEFFEY, L. C.**
HAIGHT, CAMERON, and TOWSLEY, HARRY A.: Congenital atresia of the esophagus with tracheo-esophageal fistula: extrapleural ligation of fistula and end-to-end anastomosis of esophageal segments (ab), Jan., 94
HALLEY, GUILLERMO: Case of Ewing tumor of the right femur, in the epiphysis, with unusual pathological fracture (ab), Jan., 103
HALLOCK, PHILLIP. See **RIGLER, LEO G.**
HAMILTON, JOSEPH G., SOLEY, MAYO H., REILLY, WILLIAM A., and EICHORN, KARL B.: Radioactive iodine studies in childhood hypothyroidism (ab), June, 604
HAND
See also Fingers and Toes
—disabling changes in hands resembling sclerodactylia following myocardial infarction (ab), Alf C. Johnson, April, 419
HAND, B. HOLLIS, and GILMORE, WILLIAM E.: Gallstone ileus; recurrence in one case (ab), March, 307
HAND-SCHÜLLER-CHRISTIAN SYNDROME. See Schüller-Christian Syndrome
HANKINS, WALTER D.: Traumatic hernia of lateral pharyngeal walls; case, May, 499
HARA, H. JAMES. See **BRUNNER, HANS**
HARMON, PAUL H.: Arthroplasty of the hip for osteoarthritis, utilizing foreign-body cups of plastic (ab), Jan., 100
Hemangioma of the synovial membrane of the knee joint cured by synovectomy (ab), May, 516
HARPER, R. A. KEMP: Radiological changes in carotid-cavernous aneurysm (ab), Feb., 202
HARRELL, GEORGE T., and JOHNSTON, CHRISTOPHER: Pericardial effusion in myxedema (ab), March, 303
HARRIS, IVOR D. See **BOYS, FLOYD**
HARRIS, JOHN H.: Roentgen treatment of acute bursitis of the shoulder (ab), April, 423
HARRIS, WILLIAM H., Jr. See **SCHATTENBERG, HERBERT J.**
HARTWELL, ALFRED S., and TILDEN, IRVIN L.: Aneurysm of the pulmonary artery: report of case in which the aneurysm apparently developed under observation (ab), June, 606

HAWES, LLOYD E. See **HOLMES, GEORGE W.**
HAWLEY, SYDNEY J.: Minor roentgen therapy (ab), May, 525
HAYNES, ELMER: Thymic tumor in myasthenia gravis: a case report (ab), April, 410
HEAD
See also Cranium
—radiodermatitis of head and neck with a discussion of its surgical treatment (ab), F. A. Figi, G. B. New, and C.R. Dix, May, 527
wounds and injuries
—notes on radiography of head injuries (ab), E. W. Frecker, March, 300
HEART
abnormalities. See also Ductus Arteriosus
—atrial septal defect; report of two cases in which there was recurrent laryngeal nerve paralysis (ab), Herman Erlanger and Samuel A. Levine, May, 513
—tetralogy of Fallot (ab), Irwin Feigin and Julius Rosenthal, April, 412
calcification
—technic for locating and identifying pericardial and intracardiac calcifications (ab), Merrill C. Sosman, May, 512
dilatation. See also Aneurysm, cardiac
—atypical (virus type) pneumonia with cor pulmonale (ab), Robert M. Woolford and Joseph H. Ogura, March, 302
—chronic cor pulmonale (ab), Leo G. Rigler and Phillip Hallock, May, 512
displacements
—isolated dextrocardia, with diodrast studies (ab), Arthur Ruskin, Herman Tarnower, Berton Lattin, and George P. Robb, March, 303
electrocardiography
—cardiac aneurysm: report of case with correlation of clinical, radiological and electrocardiographic findings (ab), Driver Rowland, March, 304
—electrocardiographic changes during pneumoencephalography (ab), Malcolm W. Bick and Bernard S. Epstein, March, 300
hypertrophy
—roentgenologic diagnosis of right-sided enlargement (ab), M. L. Sussman, A. Grishman, and M. F. Steinberg, Feb., 201
infarction
—disabling changes in hands resembling sclerodactylia following myocardial infarction (ab), Alf C. Johnson, April, 419
—Dupuytren's contracture as sequel to coronary artery disease and myocardial infarction (ab), Kenneth C. Kehl, March, 311
roentgenography
—angiocardiography in congenital heart disease: intracardiac shunts (ab), M. F. Steinberg, A. Grishman, and M. L. Sussman, Jan., 93
—angiocardiography in congenital heart disease: patent ductus arteriosus (ab), M. F. Steinberg, A. Grishman and M. L. Sussman, April, 411
—aortic arch and cardiac mensuration, David E. Ehrlich, April, 382
—cardiac aneurysm: report of case with correlation of clinical, radiological and electrocardiographic findings (ab), Driver Rowland, March, 304
—"mitralization" of cardiovascular silhouette in postero anterior roentgenogram (ab), Robert Shapiro, Feb., 201
—new apparatus for stereoscopic fluoroscopy; the stereoroentgenoscope. Orthodiagraphy with stereoroentgenoscope (ab), Max Hopf, March, 304
size. See also Heart, hypertrophy; Heart roentgenography
—heart size and pulmonary findings during acute coronary thrombosis (ab), Edward Massie and Wallace C. Miller, April, 410
—original observation: "accordion heart" caused by anemia (ab), Rodolfo F. Scharer and Eugenio R. Pietrafesa, June, 607
valves. See also Mitral Valve
—technic for locating and identifying pericardial and intracardiac calcifications (ab), Merrill C. Sosman, May, 512
HEFKE, H. W.: Cholecystography with Priodax: a report on 600 examinations, March, 233
HEIMANN, H. L., and POSEL, M. M.: Case of congenita dilatation of the pulmonary artery (ab), June, 607
HELLENDALL, HUGO: Multiple carcinoma: clinical picture, diagnosis and prognosis (ab), May, 524
HEMANGIOMA. See Tumors, angioma
HEMEON, W. C. L., and EVANS, ROBLEY D.: Ventilation requirements for radium dial painters (ab), March, 318
HEMOENCEPHALIC BARRIER
—study with radioactive isotopes of permeability of blood-cerebrospinal fluid barrier to ions (ab), David M. Greenberg, et al, May, 529
HEMPHILL, JAMES E. See **KUHN, HAROLD H.**
HEMPSTEAD, BERT E. See **FIGI, FREDERICK A.**
HENDERSON, SAMUEL G.: Comparative value of roentgen versus clinical methods of pelvic examination in obstetrics: roentgenologic aspects (ab), Jan., 101
HENLINE, ROY B., and MENNING, JOSEPH H.: Management of hydronephrosis due to ureteropelvic obstruction: preliminary report (ab), May, 519
HEPARIN
—effect of heparinization on experimental post-irradiation tissue changes in lung: preliminary study (ab), Floyd Boys and Ivor D. Harris, Jan., 104
HERBUT, PETER A., and SMITH, THOMAS T.: Constricting double aortic arch: report of case (ab), April, 411
HERGER, CHARLES C., and SAUER, HANS R.: Consideration of response of bladder tumors to external radiation (ab), May, 524
HERNIA
diaphragmatic
—gastric herniation at esophageal hiatus (ab), John W. Turner, Feb., 202
—medical aspects of hiatal hernia (review of 65 cases) (ab), Wm. H. Higgins, Jan., 94
—treatment of dysphagia from hernia through esophageal hiatus (ab), Porter P. Vinson, April, 412
pharyngeal
—traumatic hernia of lateral pharyngeal walls: case, Walter D. Hankins, May, 499
HICKEN, N. FREDERICK, and CORAY, Q. B.: The perforating gallbladder: report of 24 cases (ab), March, 308
HIGGINS, WM. H.: Medical aspects of hiatal hernia (ab), Jan., 94
HILL, J. M. See **WATSON, JAMES R.**
HILTON, GWEN: Some observations on the x-ray treatment of ankylosing spondylitis (ab), May, 526
HIP
See also Femur; Ilium
diseases
—arthroplasty of hip for osteoarthritis, utilizing foreign-body cups of plastic (ab), Paul H. Harmon, Jan., 100
—tabetic arthropathy of the hip; case, Irving Wolin, Jan., 79
dislocations
—congenital dislocation (ed), Feb., 188
—traumatic dislocation with fracture of acetablum (ab), Alfred M. Okelberry, Jan., 100
HODGKIN'S DISEASE
—lymphogranulomatosis and tuberculosis (ab), André Grosjean, March, 316
—lymphogranulomatosis, with a secondary tumor of pharynx of similar nature (ab), N. Puente Duany, Jan., 103
HODGSON, A. R.: Congenital retardation in development of the carpal navicular, first metacarpal, and styloid process of the radius (ab), Feb., 206
HOFFMAN, JAMES MORTIMER (obit), May, 504
HOLLANDER, A. GERSON, and CRAWFORD, J. HAMILTON: Roentgenologic and electrocardiographic changes in the normal heart during pregnancy (ab), April, 410
HOLMES, GEORGE W., and HAWES, LLOYD E.: Radiation treatment of lymphangioma (ab), Jan., 103
——**and MUELLER, H. PETER:** Treatment of post-irradiation erythema with chlorophyll ointment (ab), March, 318
HOLVEY, ERVIN H., and ROSENTHAL, LOUIS M.: Tomography in region of maxillary sinuses, May, 458
HOOKWORM INFECTION
—roentgenologic changes (deficiency pattern) in small intestine in presence of hookworm (ab), George R. Krause and James A. Crilly, Jan., 96
HOPF, MAX: New apparatus for stereoscopic fluoroscopy: the stereoroentgenoscope. II. Orthodiagraphy with the stereoroentgenoscope (ab), March, 304
HORMONES
sex
—castration in malignant and non-malignant disease, Benjamin H. Orndoff, Feb., 159
—regenerative processes induced by gonadotropic hormones in irradiated testes of albino rat, Emanuele Momigliano and J. M. Essenberg, March, 273
HORWITZ, MORIS. See **SHAPIRO, MORRIS J.**
HORWITZ, THOMAS: Eosinophilic granuloma of the tibia: case report (ab), April, 418
HOWARD, JOHN C., Jr. See **DEWEESE, E. R.**
HOWE, JOHN S. See **MANDEVILLE, F. B.**
HOWES, WILLIAM E.: Kidney tumors. Classification, review of symptoms, methods of diagnosis, therapy and end-results, April, 319
HURST, ARTHUR: Dyschezia and megacolon, Feb., 128. See communication, Feb., 190
HUSSEY, HUGH H. See **VEAL, JAMES R.**
HUTCHISON, ROBERT G.: Osteochondritis dissecans: records of some unusual cases (ab), Feb., 207
HYDRONEPHROSIS
—management of hydronephrosis due to ureteropelvic obstruction; preliminary report (ab), Roy B. Henline and Joseph H. Menning, May, 519
HYPOTHALAMUS
tumors
—motor changes observed fluoroscopically in colon of patient afflicted with tumor in hypothalamic region (ab), A. Mayoral, March, 307

I

ILEOCECAL VALVE
—enlargement (ab), Ross Golden, Feb., 203
ILEUM. See Intestines
ILEUS. See Intestines, obstruction
ILIUM
cancer
—bilateral carcinoma of adrenal cortex with metastasis to iliac bone (ab), Mather Cleveland and Leila C. Knox, March, 309
INDUSTRY AND OCCUPATIONS
—study of industrial workers exposed to sulfur dust (ab), Sherman S. Pinto, R. Alec Brown, and B. Hardy Carlton, April, 409

INDUSTRY AND OCCUPATIONS—*cont.*
diseases and poisoning. See also Pneumoconiosis
—inhalation pneumonia from nitric fumes, Mortimer R. Camiel and Henry S. Berkan, Feb., 175
—prevention and control of hazards in radium dial painting industry (ab), L. F. Curtiss, March, 318
—protection of radium dial painters—specific work habits and equipment (ab), George E. Morris, Irving R. Tabershaw, John B. Skinner, and Manfred Bowditch, March, 318
—protection of radium dial workers and radiologists from injury by radium (ab), Robley D. Evans, March, 318
—storage of radium dial instruments (ab), Charles R. Williams and Robley D. Evans, March, 318
—ventilation requirements for radium dial painters (ab), W. C. L. Hemeon and Robley D. Evans, March, 318
INFANTS
See also Children
—agenesis of lung in an infant (ab), Charles T. Olcott and Samuel W. Dooley, April, 409
—congenital absence of lung diagnosed before death, E. R. Deweese and John C. Howard, Jr., April, 389
—delayed ossification of temporal bone (in infant with meningitis) (ab), Hans Brunner and H. James Hara, Feb., 205
—diagnosis of virus pneumonitis in infancy (ab), John L. Gedgoud, Feb., 198
—osteomyelitis of long bones in newborn (ab), Samuel Stone, Jan., 99
—perforation of ileum in newborn infant with operation and recovery; case (ab), H. A. Agerty, A. J. Ziserman, and C. L. Shollenberger, June, 608
—pneumothorax in newborn infant; 3 cases (ab), G. W. Salmon and G. B. Forbes, June, 605
—primary liver-cell carcinoma in infancy; two cases, one showing calcification (ab), Wray J. Tomlinson and Ernst Wolff, April, 416
INFARCTION. See Bones, infarction; Heart, infarction
INFECTION
—roentgen therapy with low dosage in suppurative infections, H. H. Pool, March, 255
INFLAMMATION
—theories on effectiveness of roentgen therapy in inflammatory conditions, J. Borak, March, 249
INGERSOLL, C. F.: Ice skater's fracture: a form of fatigue fracture (ab), May, 515
INGRAHAM, FRANC D., and MATSON, DONALD D.: Spina bifida and cranium bifidum: unusual nasopharyngeal encephalocele (ab), Feb., 196
——**and SCOTT, H. WILLIAM, Jr.:** Spina bifida and cranium bifidum: Arnold-Chiari malformation: study of 20 cases (ab), Feb., 196
INSULIN
—radioactive phosphate as indicator of relationship between phosphate changes of blood, muscle and liver, following administration of insulin (ab), Nathan O. Kaplan and David M. Greenberg, May, 529
INTER-AMERICAN COLLEGE OF RADIOLOGY
—April, 400
INTERVERTEBRAL DISKS. See Spine, intervertebral disks
INTESTINES
See also Cecum; Colon; Duodenum; etc.
cancer
—carcinoid tumors (so-called) of ileum; report of 13 cases in which there was metastasis (ab), Malcolm B. Dockerty and Frank S. Ashburn, April, 415
—carcinoma of large bowel, excepting the rectum (ab), O. Hauptli, Jan., 97
diseases
—chronic non-specific jejunitis with unusual features (ab), Walter R. Johnson, April, 414
diverticula
—nonmeckelian diverticula of jejunum and ileum (ab), Raymond E. Benson, Claude F. Dixon, and John M. Waugh, April, 414
foreign bodies
—gallstone ileus; recurrence in one case (ab), B. Hollis Hand and William E. Gilmore, March, 307
—intestinal obstruction due to gallstone (ab), Robert L. Nitkin and Albert Lesser, March, 308
intussusception. See Intussusception
motility
—motor changes observed fluoroscopically in colon of patient afflicted with a tumor in hypothalamic region (ab), A. Mayoral, March, 307
obstruction
—gallstone ileus; recurrence in one case (ab), B. Hollis Hand and William E. Gilmore, March, 307
—intestinal obstruction due to gallstone (ab), Robert L. Nitkin and Albert Lesser, March, 308
—strangulating obstruction with negative roentgenologic findings (ab), Leon Goldman, Jan., 96
perforation
—of ileum in newborn infant with operation and recovery; case (ab), H. A. Agerty, A. J. Ziserman, and C. L. Shollenberger, June, 608
roentgenography
—roentgenologic changes (deficiency pattern) in small intestine in presence of hookworm (ab), George R. Krause and James A. Crilly, Jan., 96
tumors. See also Intestines, cancer
—primary lymphosarcoma in boy of seven. Follow-up of nine years (ab), Herman Charache, March, 317
volvulus
—volvulus of cecum and ascending colon, with review of literature and presentation of case (ab), Milton Rothman, John P. Bruckner, and Dominick F. Zetena, May, 514
INTUSSUSCEPTION
—entero-enteric intussusception, C. Allen Good, Feb., 122
—of appendix (ab), Kenneth Fraser, Feb., 203
IODINE AND IODINE COMPOUNDS
See also Gallbladder, roentgenography
iodized oil
—unusual complication of intraspinal use (ab), Paul C. Bucy and Irving J. Speigel, April, 420
radioactive. See Radioactivity
IONS
—study with radioactive isotopes of permeability of blood-cerebrospinal fluid barrier to ions (ab), David M. Greenberg, et al, May, 529
IRVINE, ARCHIE DUNCAN (obit), April, 400

J

JACKSON, RICHARD G. See **COLLER, FREDERICK A.**
JAFFE, SAMUEL A., and MENDILLO, ANTHONY J.: Primary carcinoma of the ureter (ab), May, 520
JAGER, B. V., and RANSMEIER, J. C.: Constrictive pericarditis due to Bacterium tularense. Report of a case and review of reported cases of pericarditis occurring with tularemia (ab), March, 303
JAWS
—multiple myeloma first discovered in the mandible; case, Ernest Wolff and Lewis E. Nolan, Jan., 76
diseases
—osteitis fibrosa cystica: differential diagnosis, with note on repair of maxillary lesion by cartilaginous isograft (ab), Noah Fox and Vito Taglia, April, 418
tumors
—adamantinoma: report of 8 cases (7 in jaw; one in pituitary body) (ab), L. K. Chont, May, 511
—osteochondroma of coronoid process of mandible (ab), Richard T. Shackelford and Webster H. Brown, Feb., 197
JEJUNUM. See Intestines.
JENKINSON, E. L., and BROWN, W. H.: Endometriosis: Study of 117 cases with special reference to constricting lesions of the rectum and sigmoid colon (ab), Jan., 97
JOHNSON, ALF C.: Disabling changes in the hands resembling sclerodactylia following myocardial infarction (ab), April, 419
JOHNSON, WALTER R.: Chronic, non-specific jejunitis with unusual features (ab), April, 414
JOHNSTON, CHRISTOPHER. See **HARRELL, GEORGE T.**
JOHNSTON, JAMES R.: Carcinoma of the cervix: study of 233 cases including 103 five-year cases with a survival rate of 33.9 per cent (ab), Feb., 212
JOHNSTON, MARGARET. See **ROBINOW, MEINHARD**
JOHNSTON, W. H.: Osteoma of the frontal sinus; report of a case (ab), May, 511
JOHNSTONE, A. S.: Radiological sign of pyloric stenosis (ab), Feb., 202
——See **ALLISON, P. R.**
JOINTS. See under names of joints
JONES, D. E. A. See **CLARK, L. H.**
JONES, HAROLD W. See **ERF, LOWELL A.**
JONES, HORACE L., Jr. See **SCOTT, WENDELL G.**

K

KAHN, EDGAR A.: Contrast media in lesions of the cerebral hemisphere (ab), Jan., 90
KANTOR, HERMAN I.: Parasitic ovarian cysts (ab), May, 518
KAPLAN, IRA I.: Hemangioma of the elbow successfully treated with radium at an early age (ab), April, 423
KAPLAN, NATHAN O., and GREENBERG, DAVID M.: Radioactive phosphate as an indicator of the relationship between the phosphate changes of blood, muscle, and liver, following administration of insulin (ab), May, 529
KEEN, P. See **STORR, N. V.**
KEHL, KENNETH C.: Dupuytren's contracture as a sequel to coronary artery disease and myocardial infarction (ab), March, 311
KERNWEIN, GRAHAM A., and QUEEN, FRANK B.: Solitary eosinophilic granuloma: report of case (ab), Feb., 209
KEROSENE
—pulmonary manifestations following ingestion of kerosene (ab), Leonard I. Lesser, H Stephen Weens, and John D. McKey, June, 605
KERR, H. DABNEY, and STEPHENS, ROBERT L.: Roentgen rays in the treatment of malignant tumors of the kidney in adults (ab), March, 315
KHOO, F. Y.: Juvenile elongation of the aorta (ab), March, 306
KIDNEYS
abnormalities
—ectopia; 2 cases, with new method of x-raying pelvic ectopia (ab), Nicholas S. Scarcello, May, 519
function
—estimation of renal function based on specific gravity changes following intravenous urography (ab), George O. Baumrucker, May, 518

KIDNEYS—*cont.*
pelvis
—management of hydronephrosis due to ureteropelvic obstruction; preliminary report (ab), Roy B. Henline and Joseph H. Menning, May, 519
—ureteropelvic obstruction due to extrinsic and intrinsic lesions of ureter as clinical entity and its treatment (ab), Clyde L. Deming, June, 613
renal rickets. See Rickets
rupture
—traumatic rupture (ab), Payson Adams, April, 419
tumors
—adenoma, with associated lesions; 3 cases (ab), Henry Bugbee, May, 521
—classification, review of symptoms, methods of diagnosis, therapy and end-results, William E. Howes, April, 319
—malignant tumors; review of 117 cases, Louis C. Bixler, K. Wilhelm Stenstrom, and C. D. Creevy, April, 329
—roentgen rays in treatment of malignant tumors in adults (ab), H. Dabney Kerr and Robert L. Stephens, March, 315
—roentgen therapy of Wilms' tumor, Edward W. Rowe and Maurice D. Frazer, Feb., 107
—Wilms' tumor; clinico-pathologic study of 44 proved cases (ab), Wilson Weisel, Malcolm B. Dockerty, and James T. Priestley, June, 615
—Wilms' tumor in adult; case (ab), Martin J. Loeb, May, 519
wounds and injuries
—radiologic findings and anatomo-pathological results of experimental renal trauma (ab), Armando Trabucco, March, 312
KIRKLIN, B. R.: Mistakes and misunderstandings in the roentgenologic diagnosis of gastric cancer (ab), Jan., 95
——See **RIGOS, FRANK J.**
KIRSHBAUM, JACK D., LARKIN, HERBERT S., and CULVER, HARRY: Retothel sarcoma of prostate gland: report of case (ab), June, 615
KNEE
cysts
—Baker's cyst: posterior herniation of knee joint, Harold H. Kuhn and James E. Hemphill, March, 237
—posterior hernia (Baker's cyst, popliteal cyst, semimembranosus bursitis, medial gastrocnemius bursitis, and popliteal bursitis) (ab), Henry W. Meyerding and Robert E. VanDemark, Feb., 208
roentgenography
—air arthrography in diagnosis of internal derangement of knee joint (ab), E. W. Somerville, May, 516
tumors
—hemangioma of synovial membrane of knee joint cured by synovectomy (ab), Paul H. Harmon, May, 516
—synovioma involving knee joint; case (ab), Malcolm S. Eveleth and Philip S. Brezina, May, 516
KNIGHT, RICHARD van DYCK: Superficial noninvasive intraepithelial tumors of the cervix (ab), May, 523
KNOX, LEILA C. See **CLEVELAND, MATHER**
KRAFT, ERNEST: Epidermoid carcinoma of the tibia: report of 2 cases (ab), June, 612
KRAUSE, GEORGE R., and CRILLY, JAMES A.: Roentgenologic changes in the small intestine in the presence of the hookworm (ab), Jan., 96
KRESKY, PHILIP J. See **STEIN, GEORGE H.**
KRUGER, ALFRED L. See **TRIPODI, ANTONIO M.**
KUHN, HAROLD H., and HEMPHILL, JAMES E.: Baker's cyst: posterior herniation of the knee joint, March, 237
KULICK, MAX. See **EPSTEIN, BERNARD S.**

L

LABOR
complications
—value of pelviroradiography in management of dystocia (ab), Arthur Weinberg and Samuel J. Scadron, March, 311
LAMINAGRAPHY. See Body Section Roentgenography
LAPP, WARREN A. See **McGOLDRICK, J. L.**
LARKIN, HERBERT S. See **KIRSHBAUM, JACK D.**
LARKIN, VINCENT deP. See **DeSANCTIS, ADOLPH G.**
LARSON, SIDNEY, and LICHTY, JOHN A., Jr.: Gargoylism: report of 3 probable cases (ab), Feb., 206
LARYNX
—mechanism of phonation demonstrated by planigraphy of larynx (ab), Bruno L. Griesman, April, 406
diseases
—x-ray treatment (ab), Maurice Lenz, April, 422
tuberculosis
—roentgen therapy (ab), Clarence W. Engler, May, 525
LASNITZKI, ILSE: Response of cells in vitro to variations in x-ray dosage (ab), April, 424
LATTIN, BERTON. See **KUSKIN, ARTHUR**
LAWSON, LAWRENCE J.: Primary carcinoma of the eustachian tube: a study of the evidence of its occurrence (ab), Feb., 211
LEDDY, EUGENE T. See **NASH, LEO A.**
LEGION OF MERIT
—awarded to Major George S. Maxfield, March, 293
LEGS
blood supply
—significance of phlebography in phlebothrombosis (ab), M. E. DeBakey, G. F. Schroeder, and A. Ochsner, June, 614
—venography: I. Its use in differential diagnosis of peripheral venous circulation; II. Simplified technic (ab), Jerome Mark, May, 521
—venography of lower extremity: new technic—preliminary report (ab), Emile Zax, March, 314
LEIOMYOSARCOMA. See Sarcoma, myosarcoma
LeMONE, DAVID V., and COOPER, WILLIAM GRANT, Jr.: Total subphrenic abscess, March, 283
LEMOS IBÁÑEZ, ANIBAL. See **MOLINARI, JOSÉ LUIS**
LENZ, MAURICE: X-ray treatment of diseases of larynx (ab), April, 422
LEPROSY
—absorptive bone changes in leprosy, J. P. Cooney and E. H. Crosby, Jan., 14
—bone changes in leprosy: clinical and roentgenologic study of 505 cases, G. H. Faget and A. Mayoral, Jan., 1
LESSER, ALBERT. See **NITKIN, ROBERT L.**
LESSER, LEONARD I., WEENS, H. STEPHEN, and McKEY, JOHN D.: Pulmonary manifestations following ingestion of kerosene (ab), June, 605
LEUKEMIA
—induction of leukemia in mice by methylcholanthrene and x-rays (ab), D. P. McEndy, Mary C. Boon, and Jacob Furth, Jan., 104
lymphatic
—use of basal metabolic rate in management of radiotherapy for leukemia, Erich M. Uhlmann and Martin Goldner, Feb., 165
myelogenous
—leukemia and pregnancy; case report and review of literature (ab), J. L. McGoldrick and Warren A. Lapp, June, 617
—use of basal metabolic rate in management of radiotherapy for leukemia, Erich M. Uhlmann and Martin Goldner, Feb., 165
LEVENE, GEORGE, and STERMAN, IDA A.: Roentgen study of primary atypical virus pneumonia, May, 446
LEVI, SAM: Determination of the position of calcium deposits and foreign bodies from stereoscopic films without the use of a viewing stereoscope, Jan., 71
LEVINE, SAMUEL A. See **ERLANGER, HERMAN**
LEVITIN, JOSEPH. See **COHN, ALLAN L.**
LEVY, SOL. See **LURIE, LOUIS A.**
LEWIS, ELBERT K., and LUSK, FRANK B.: Roentgen diagnosis of primary atypical pneumonia, May, 425
LICHTENSTEIN, GEMMA M. See **SERBY, A. M.**
LICHTY, J. M. See **WATSON, JAMES R.**
LICHTY, JOHN A., Jr. See **LARSON, SIDNEY**
LIPFORD, JANET. See **SONTAG, LESTER W.**
LIPOCHONDRODYSTROPHY
—gargoylism: report of 3 probable cases (ab), Sidney Larson and John A. Lichty, Jr., Feb., 206
LIVER
—radioactive phosphate as indicator of relationship between phosphate changes of blood, muscle and liver, following administration of insulin (ab), Nathan O. Kaplan and David M. Greenberg, May, 529
cancer
—primary liver-cell carcinoma in infancy; two cases, one showing calcification (ab), Wray J. Tomlinson and Ernst Wolff, April, 416
LOEB, MARTIN J.: Report of a case of Wilms' tumor in an adult (ab), May, 519
LÖFFLER'S SYNDROME. See Eosinophils
LOGUE, R. BRUCE: Dissecting aneurysm of the aorta (ab), Feb., 201
LOVE, J. GRAFTON, and WALSH, MAURICE N.: Protruded intervertebral disks (ab), June, 610
LOWMAN, ROBERT M. See **WISSING, EGON G.**
LUDWIG, HERBERT: Significance of a close co-operation between the roentgenologist and the internist (ab), Feb., 211
LUNGS
absence
—agenesis in infant (ab), Charles T. Olcott and Samuel W. Dooley, April, 409
—congenital absence, diagnosed before death; case, E. R. Deweese and John C. Howard, Jr., April, 389
blood supply
—atypical (virus type) pneumonia with cor pulmonale (ab), R. M. Woolford and J. H. Ogura, March, 302
calcification
—miliary calcification (ab), Erving F. Geever, Jan., 90
cancer
—bronchogenic carcinoma (ab), Foster Murray, April, 408
—carcinoma of lung, with freedom from symptoms for five years (ab), N. Puente Duany and W. Figueras Gonzáles, Jan., 103
—massive conglomerate lesions of silicosis differentiated from pulmonary neoplasm (ab), Richard A. Rendich and Mortimer R. Camiel, May, 511
—pulmonary metastasis and pneumonitis following radiation therapy for cancer of breast (ab), Eugene P. Pendergrass and George White, May, 522
—review of 31 proved cases at the Philadelphia Naval Hospital (ab), Ferdinand Fetter, Jan., 92
—roentgen diagnosis of bronchiogenic carcinoma, Harold L. Shinall, March, 213
collapse
—obstructive emphysema and atelectasis in tuberculosis of infants and children (ab), Julio Meneghello and Clement A. Smith, June, 604
cysts
—surgical management of solitary cysts, or cyst-like structures (ab), M. Dawson Tyson, March, 302

LUNGS—*cont.*
diseases. See also Pneumoconiosis; Tuberculosis, Pulmonary
—types encountered in an Army camp (ab), Morris C. Thomas, Feb., 197
fibrosis
—effect of heparinization on experimental post-irradiation tissue changes in lung: preliminary study (ab), Floyd Boys and Ivor D. Harris, Jan., 104
—xanthomatosis—Hand-Schüller-Christian type: report of a case with pulmonary fibrosis (ab), James H. Currens and Walter C. Popp, Jan., 92
necrosis
—liquefaction necrosis in bilateral symmetrical conglomerate lesions of anthraco-silicosis of lung: report of case (ab), Bernard J. McCloskey, Feb., 291
pathology
—heart size and pulmonary findings during acute coronary thrombosis (ab), Edward Massie and Wallace C. Miller, April, 410
—Löffler's syndrome; case (ab), James H. Smith, Jan., 91
—pulmonary manifestations following ingestion of kerosene (ab), Leonard I. Lesser, H. Stephen Weens, and John D. McKey, June, 605
roentgenography. See Tuberculosis, Pulmonary, mass roentgenologic surveys
tuberculosis. See Tuberculosis, Pulmonary
tumors
—cavernous hemangioma; secondary polycythemia (ab), Alfred Goldman, June, 606
wounds and injuries
—symposium on management of Cocoanut Grove burns at Massachusetts General Hospital. Roentgenologic report of pulmonary lesions (ab), Richard Schatzki, March, 301
LURIE, LOUIS A., LEVY, SOL, and LURIE, MAX L.: Determination of bone age in children. Method based on study of 1,129 white children (ab), June, 609
LURIE, MAX L. See **LURIE, LOUIS A.**
LUSK, FRANK B. See **LEWIS, ELBERT K.**
LUTZ, R. J. See **CAMPBELL, THOMAS A.**
LUTZ, W.: Good result in radium treatment of an extensive cavernous hemangioma (ab), March, 315
LYMPH NODES
cancer
—diagnosis of cervical metastasis from squamous carcinoma of the mouth and throat (ab), C. A. Whitcomb, March, 300
—spread of carcinoma of rectum; invasion of lymphatics, veins and nerves (ab), Philip H. Seefeld and J. Arnold Bargen, March, 307
LYMPHANGIOMA. See Tumors, angioma
LYMPHOEPITHELIOMA. See Nasopharynx, cancer
LYMPHOGRANULOMA
Hodgkin's. See Hodgkin's Disease
LYMPHOID TISSUE. See Nasopharynx; Tonsils
LYMPHOSARCOMA. See Sarcoma, lymphosarcoma

M

McCAW, W. W.: Training of x-ray technicians at the School for Medical Department Enlisted Technicians, April, 384
McCLOSKEY, BERNARD J.: Liquefaction necrosis in bilateral symmetrical conglomerate lesions of anthraco-silicosis of the lung: report of a case (ab), Feb., 201
McCORMICK, NORMAN A.: Cancer of the rectum, June, 531
McCULLOUGH, DAVID: Tuberculous tracheobronchitis (ab), April, 407
MACDONALD, IAN, and BUDD, JOHN W.: Osteogenic sarcoma: I. Modified nomenclature and a review of 118 five year cures (ab), May, 524
McENDY, D. P., BOON, MARY C., and FURTH, JACOB: Induction of leukemia in mice by methylcholanthrene and x-rays (ab), Jan., 104
McGOLDRICK, J. L., and LAPP, WARREN A.: Leucemia and pregnancy: case report and review of literature (ab), June, 617
MACHT, STANLEY H.: Foreign body (bottle) in rectum; case, May, 500
McILWAIN, ALBERT J. See **MAXFIELD, J. R., Jr.**
McINTOSH, HARRIET C.: Roentgen therapy of pelvic tuberculosis in the female, Jan., 48
McKEY, JOHN D. See **LESSER, LEONARD I.**
MACKTA, LEO: An adaptor for fluoroscopic depth localization (ab), May, 521
McLACHLIN, A. D.: Treatment and results in localized osteitis fibrosa cystica (solitary bone cyst) (ab), May, 515
McLAURIN, JOHN G.: Interrelationship of upper and lower respiratory infections, emphasizing the routes of infection, April, 406
McNATTIN, ROBERT F.: Treatment of osteogenic sarcoma with preoperative roentgen radiation in large doses, March, 246
McSWEENEY, DANIEL J., and MALONEY, ALBERT M.: Combined x-ray and external pelvimetry (ab), Feb., 210
McWHIRTER, R.: Value of post-operative radiotherapy in carcinoma of breast (ab), April, 422
MALARIA
—primary atypical pneumonia and malaria (ab), Edgar T. Campbell, April, 408
MALBIN, M., and STENSTROM, K. WILHELM: Results of treatment of 173 cases of carcinoma of the rectum, June, 545
MALTA FEVER. See Undulant Fever
MANDEVILLE, F. B.: Multiple saccular aneurysms of the aorta with roentgen and necropsy findings (ab), Jan., 93
—**and HOWE, JOHN S.:** Giant-cell tumor of the lower femur. Case report with roentgen and pathological findings before and after curettage and roentgen therapy with amputation for sarcoma, Jan., 56
MANDIBLE. See Jaws
MARCH FRACTURE. See Fibula, fractures; Foot, fractures; Fractures; Metatarsus, fractures; Pubic Bone, fractures
MARIE-STRÜMPELL DISEASE. See Spine, arthritis
MARK, JEROME: Venography. I. Its use in the differential diagnosis of the peripheral venous circulation. II. Simplified technic (ab), May, 521
MARTIN, CHARLES L.: X-ray treatment of bone tumors (ab), May, 523
MASON, JAMES BOYD (obit), March, 294
MASON, M. W.: Adequacy of the photofluorographic method of chest survey (ab), April, 406
MASS ROENTGENOLOGIC SURVEYS. See Tuberculosis, Pulmonary, mass roentgenologic surveys
MASSIE, EDWARD, and MILLER, WALLACE C.: Heart size and pulmonary findings during acute coronary thrombosis (ab), April, 410
MASTOID
tumors
—malignant tumors (ab), Frederick A. Figi and Bert E. Hempstead, April, 420
MATSON, DONALD D. See **INGRAHAM, FRANC D.**
MAXFIELD, GEORGE S.
—awarded Legion of Merit, March, 293
MAXFIELD, J. R., Jr., and McILWAIN, ALBERT J.: Diagnostic value of pneumoperitoneum, April, 346
MAXILLA. See Jaws
MAXILLARY SINUS
See also Sinuses, Paranasal
—tomography in region of maxillary sinuses, Ervin H. Holvey and Louis M. Rosenthal, May, 458
MAYORAL, A.: Motor changes observed fluoroscopically in the colon of a patient afflicted with a tumor in the hypothalamic region (ab), March, 307
——See **FAGET, G. H.**
MAZER, CHARLES, and GREENBERG, ROSE: Low-dosage irradiation in the treatment of amenorrhea: analysis of an additional 92 cases (ab), June, 618
MEDIASTINUM
cysts
—bronchogenic cysts, with report of 3 cases (ab), W. E. Adams and T. F. Thornton, Jr., March, 302
—roentgenologic appearance of "bronchiogenic" cysts (ab), Laurence L. Robbins, April, 408
—"spring-water" cyst; case report (ab), Irving Greenfield, Israel Steinberg, and Arthur S. W. Touroff, Jan., 93
MEDICAL ECONOMICS
—political realism (ed), Sydney J. Hawley, June, 597
MEGACOLON. See Colon, dilatation
MENDILLO, ANTHONY J. See **JAFFE, SAMUEL A.**
MENEGHELLO, JULIO, and SMITH, CLEMENT A.: Obstructive emphysema and atelectasis in tuberculosis of infants and children (ab), June, 604
MENG, C. M., and WU, Y. K.: Tuberculosis of the flat bones of the vault of the skull: a study of 40 cases (ab), May, 510
MENINGITIS
—delayed ossification of temporal bone (in infant with meningitis) (ab), Hans Brunner and H. James Hara, Feb., 205
MENINGOCELE
—anterior sacral meningocele (ab), Frederick A. Coller and Richard G. Jackson, Jan., 99
MENNING, JOSEPH H. See **HENLINE, ROY B.**
MENSTRUATION. See Amenorrhea
MENVILLE, LEON J. See **ANÉ, J. N.**
——See **GARCIA, MANUEL**
MESCHAN, I. See **FREEDMAN, EUGENE**
MESENTERY
tumors
—solitary neurogenic sarcoma; review of literature and report of case (ab), Morris J. Shapiro and Moris Horwitz, April, 416
METABOLISM
—metabolic changes occurring as result of deep roentgen therapy: I. Effect of 200 kilovolt roentgen therapy (ab), Douglas Goldman, May, 527
—metabolic changes occurring as result of deep roentgen therapy: II. Effect of 1,000 kilovolt roentgen therapy (ab), James E. Robertson, May, 527
—use of basal metabolic rate in management of radiotherapy for leukemia, Erich M. Uhlmann and Martin Goldner, Feb., 165
METACARPUS
—congenital retardation in development of carpal navicular, first metacarpal, and styloid process of radius (ab), A. R. Hodgson, Feb., 206
fractures
—double march fracture; case (ab), Samuel R. Terhune and Thomas S. Eddleman, May, 515
—fractures of neck of metacarpal (ab), Irving Redler, Feb., 209
—march fracture (ab), H. H. Fouracre Barns, June, 611
METHYLCHOLANTHRENE
—induction of leukemia in mice by methylcholanthrene and x-rays (ab), D. P. McEndy, Mary C. Boon, and Jacob Furth, Jan., 104

MEYERDING, HENRY W., and Van DEMARK, ROBERT E:. Posterior hernia of the knee (Baker's cyst, popliteal cyst, semimembranosus bursitis, medial gastrocnemius bursitis and popliteal bursitis) (ab), Feb., 208
MILITARY MEDICINE AND SURGERY
See also Fractures
—adequacy of photofluorographic method of chest survey (ab), M. W. Mason, April, 406
—critical and casuistic contribution on the theme "fluoroscopy in the Army" (ab), H. H. Weber, Jan., 90
—foreign body localization and extraction; description of method more accurate than that used by the Army (ab), Lewis G. Cole, May, 521
—optimum kilovoltage technic in military roentgenography (ab), Arthur W. Fuchs, May, 522
—peptic ulcer at Fort George G. Meade, Md. (ab), Charles A. Flood, April, 412
—peptic ulcers and dyspepsia in the Army (ab), Henry Tidy, June, 607
—pneumonia in the Army (ab), E. V. Allen and Lester W. Baird, June, 606
—primary atypical pneumonia; report of 200 cases at Fort Eustis, Virginia (ab), Thomas A Campbell, Paul S. Strong, George S. Grier, III, and R. J. Lutz, Feb., 197
—pulmonary tuberculosis: bacteriological examinations supplementing routine thoracic radiography in Australian military forces (ab), Reginald Webster, Feb., 199
—responsibility of the roentgenologist in the wartime duodenal ulcer problem, Maurice Feldman, April, 356
—results of systematic fluoroscopy of an Army Unit on relief from service (ab), C. Frei, Jan., 90
—roentgen detection in an Army General Hospital of chronic diseases not excluded by induction boards, Lucien M. Pascucci, April, 375
—training of x-ray technicians at the School for Medical Department Enlisted Technicians, W. W. McCaw, April, 384
—types of lung diseases encountered in an Army camp (ab), Morris C .Thomas, Feb., 197
MILKMAN'S SYNDROME. See Bones, diseases
MILLER, E.: Plasmocytosis of the bone-marrow associated with metastatic carcinomatosis (ab), Feb., 209
MILLER, R. B. See **WATSON, JAMES R.**
MILLER, WALLACE C. See **MASSIE, EDWARD**
MINERALS
metabolism
—of bone salts in resistant rickets; report of case, with balance and radioactive tracer studies (ab), Lewis Gunther, Elma T. Cohn, Waldo E. Cohn, and David M. Greenberg, June, 611
MITRAL VALVE
—early radiologic recognition of mitral valve disease (ab), Bernard S. Epstein, June, 607
stricture
—"mitralization" of cardiovascular silhouette in posteroanterior roentgenogram (ab), Robert Shapiro, Feb., 201
MOEHLIG, ROBERT C.: Renal dwarfism or renal rickets (ab), June, 612
MOLINARI, JOSÉ LUIS, and LEMOS IBÁÑEZ, ANIBAL: Roentgen therapy in ano-vulvar pruritus (ab), May, 526
MOLONEY, ALBERT M. See **McSWEENEY, DANIEL M.**
MOMIGLIANO, EMANUELE, and ESSENBERG, J. M.: Regenerative processes induced by gonadotropic hormones in irradiated testes of the albino rat, March, 273
MONTGOMERY, M. LAURENCE, SHELINE, G. E., and CHAIKOFF, I. L.: Elimination of administered zinc in pancreatic juice, duodenal juice, and bile of the dog as measured by its active isotope (Zn^{65}) (ab), May, 529
MORGAN, RUSSELL H.: Control of diagnostic quality in roentgenograms of the chest (ab), March, 300
Reciprocity law failure in x-ray films, May, 471
MORRIS, GEORGE E., TABERSHAW, IRVING R., SKINNER, JOHN B., and BOWDITCH, MANFRED: Protection of radium dial painters—specific work habits and equipment (ab), March, 318
MORTON, EDWARD REGINALD (obit), June, 600
MOUTH
cancer
—diagnosis of cervical metastasis from squamous carcinoma (ab), C. A. Whitcomb, March, 300
MUDGETT, CHAS. S. See **FAUST, DANIEL B.**
MUELLER, H. PETER. See **HOLMES, GEORGE W.**
MURRAY, FOSTER: Bronchogenic carcinoma (ab), April, 408
MUSCLES
—isolated fracture of first rib produced by muscular traction; case, Robert L. Garber, April, 395
—radioactive phosphate as indicator of relationship between phosphate changes of blood, muscle and liver, following administration of insulin (ab), Nathan O. Kaplan and David M. Greenberg, May, 529
tumors. See Sarcoma, myosarcoma
MYASTHENIA GRAVIS
—thymic tumor in case (ab), Elmer Haynes, April, 410
MYELOMA
See also Bones, marrow
endothelial. See Tumors, Ewing's
MYOCARDIUM. See Heart
MYOSARCOMA See Sarcoma, myosarcoma
MYXEDEMA
—pericardial effusion in myxedema (ab), George T. Harrell and Christopher Johnston, March, 303

N

NADEL, MILTON. See **SNOW, WILLIAM**
NASAL SINUSES. See Sinuses, Paranasal
NASH, LEO A., and LEDDY, EUGENE T.: Seminoma of the testis from the standpoint of roentgen treatment (ab), March, 316
——See **CAMP, JOHN D.**
NASOPHARYNX
—recognition and radium treatment of infected and hypertrophied lymphoid tissue; preliminary report (ab), Gilbert E. Fisher, March, 317
—use of radium (to irradiate lymphoid tissue around eustachian tube) in conduction deafness (ab), Gilbert E. Fisher, March, 317
cancer
—end results of treatment of malignant lesions (ab), Gordon B. New and Walter Stevenson, April, 421
—lymphoepithelioma; case (ab), A. H. Persky, April, 421
—roentgen diagnosis (ab), W. George Belanger and Cornelius G. Dyke, Feb., 196
NATIONAL CANCER INSTITUTE
—place in cancer program, R. R. Spencer, May, 493
NAVAL MEDICINE
—carcinoma of the lung; review of 31 proved cases at the Philadelphia Naval Hospital (ab), Ferdinand Fetter, Jan., 92
NAVICULAR BONES. See Scaphoid Bone, Carpal
NECK
—radiodermatitis of head and neck with a discussion of its surgical treatment (ab), F. A. Figi, G. B. New, and C. R. Dix, May, 527
NECROSIS
See also Lungs, necrosis; Pancreas
aseptic
—in adults; caisson workers and others, Henry K. Taylor, June, 550
NERVES
—spread of carcinoma of rectum: invasion of lymphatics, veins and nerves (ab), Philip H. Seefeld and J. Arnold Bargen, March, 307
laryngeal
—atrial septal defect; report of 2 cases in which there was recurrent laryngeal nerve paralysis (ab), Herman Erlanger and Samuel A. Levine, May, 513
NETTLESHIP, A.: Tissue changes produced in C3H mice by 50 r whole body exposure, Jan., 64
NEUHAUSER, EDWARD B. D. See **DONOVAN, MARK S.**
NEUROBLASTOMA SYMPATHICUM. See Tumors, sympathoblastoma
NEUROFIBROMATOSIS
—von Recklinghausen's neurofibromatosis (ab), N. V. Storr and P. Keen, April, 418
NEUROSARCOMA. See Sarcoma, neurosarcoma
NEW, GORDON B., and STEVENSON, WALTER: End results of treatment of malignant lesions of the nasopharynx (ab), April, 421
——See **FIGI, F. A.**
NEWELL, R. R.: X-raying of school personnel (ab), Feb., 199
NICHOLSON, RICHARD E.: Syndrome of rupture of aortic aneurysm into the pulmonary artery: review of literature with report of 2 cases (ab), March, 305
NICKERSON, SAMUEL H.: March fracture or insufficiency fracture (ab), June, 611
NITKIN, ROBERT L., and LESSER, ALBERT: Intestinal obstruction due to a gallstone (ab), March, 308
NITRIC OXIDE
—inhalation pneumonia from nitric fumes, Mortimer R. Camiel and Henry S. Berkan, Feb., 175
NOLAN, LEWIS E. See **WOLFF, ERNEST**
NOMENCLATURE
—osteogenic sarcoma: I. Modified nomenclature and review of 118 five year cures (ab), Ian Macdonald and John W. Budd, May, 524
NORMENT, W. B.: Study of the uterine canal by direct observation and uterogram (ab), May, 517
NORTHUP, DAVID W. See **Van LIERE, EDWARD J.**
NOSE. See Nasopharynx

O

OBITUARIES
Baird, Lester White, Feb., 191
Baker, Charles Frederick, April, 400
Behne, Kurt Friedrich, April, 400
Clarkson, Wright, March, 293
Dwyer, Maurice Francis June, 599
Engeln, Henry P., April, 400
Hoffman, James Mortimer, May, 504
Irvine, Archie Duncan, April, 400
Mason, James Boyd, March, 294
Morton, Edward Reginald, June, 600
Sale, Onal Arthur, May, 504
OBSTETRICS
See also Labor
pelvimetry in. See Pelvis, measurement
OCCUPATIONS. See Industry and Occupations
OCHSNER, A. See **DeBAKEY, M. E.**
O'DONOGHUE, D. H., and SELL, L. STANLEY: Congenital talonavicular synostosis; case report of a rare anomaly (ab), May, 517
OGURA, JOSEPH H. See **WOOLFORD, ROBERT M.**

OKELBERRY, ALFRED M.: Traumatic dislocation of the hip with fracture of the acetabulum (ab), Jan., 100
OLCOTT, CHARLES T., and DOOLEY, SAMUEL W.: Agenesis of lung in an infant (ab), April, 409
OLIN, HARRY A.: Primary malignant neoplasm of the shoulder joint, with report of case, April, 359
OMENTUM
cysts
—traumatic serous cyst of the lesser omentum; case, Milton Birnkrant, Jan., 74
OPPENHEIMER, ALBERT: Arthritis of the acromioclavicular joint (ab), May, 516
Roentgen therapy of interstitial pneumonia (ab), June, 618
OPPENHEIMER, ELLA H. See **BAER, RIDGELY W.**
OPTIC CANAL
—technic for optic foramen roentgenography, Bernard S. Epstein and Max Kulick, Feb., 186
ORGIAS, RICHARD: Enterogenous cyst of the duodenum (ab), Feb., 202
ORNDOFF, BENJAMIN H.: Castration in malignant and nonmalignant disease, Feb., 159
ORTHOPEDICS
See also Bones; Fractures; etc.
apparatus
—improved technic for blind nailing of neck of femur; Creccatelo Cetrulo guide (ab), William D. Crecca and Gerald I. Cetrulo, April, 418
OSGOOD, ELLIS C.: Value of delayed examination in pyelography, April, 380
OSSIFICATION. See Bones, growth
OSTEITIS
condensans. See Osteosclerosis fragilis
deformans
—mono-osteitic Paget's disease as clinical entity: roentgenologic observations in 9 cases (ab), J. A. Groh, March, 310
fibrosa
—osteitis fibrosa cystica; differential diagnosis, with note on repair of maxillary lesion by cartilaginous isograft (ab), Noah Fox and Vito Taglia, April, 418
—treatment and results in localized osteitis fibrosa cystica (solitary bone cyst) (ab), A. D. McLachlin, April, 515
OSTEOARTHRITIS. See Hip
OSTEOCHONDRITIS
dissecans
—of astragalus (ab), Milton C. Cobey, May, 517
—records of some unusual cases (ab), Robert G. Hutchison, Feb., 207
OSTEOCHONDROMA. See Tumors, osteochondroma
OSTEOGENESIS IMPERFECTA. See Bones, fragility
OSTEOMA. See Tumors, osteoma
OSTEOMYELITIS
—of long bones in newborn (ab), Samuel Stone, Jan., 99
OSTEOPATHIA CONDENSANS DISSEMINATA. See Osteosclerosis fragilis
OSTEOSARCOMA. See Sarcoma, osteosarcoma
OSTEOSCLEROSIS
fragilis
—osteopathia condensans disseminata associated with coarctation of aorta; case (ab), George S. Phalen and Ralph K. Ghormley, Feb., 206
OVARY
cysts
—parasitic cysts (ab), Herman I. Kantor, May, 518
irradiation
—low-dosage irradiation to pituitary gland and ovaries in amenorrhea and dysfunctional uterine bleeding: long-term survey (ab), Leon Reidenberg, Jan., 103
—therapeutic abortion by x-rays (ab), Carlos E. Gárciga, Jan., 104
tumors
—parasitic cysts (ab), Herman I. Kantor, May, 518

P

PACKARD, JOHN S.: Importance of wheeze in the diagnosis of pulmonary tuberculosis (ab), Feb., 200
PAGET'S DISEASE
of bones. See Osteitis deformans
PALMER, WALTER L.: Duration of gastric cancer (ab), April, 414
PANCREAS
—calcareous pancreatitis: 3 cases with autopsies (ab), Joseph G. Pasternack, June, 608
—elimination of administered zinc in pancreatic juice, duodenal juice, and bile of dog as measured by its active isotope (Zn^{65}) (ab), M. Laurence Montgomery, G. E. Sheline, and I. L. Chaikoff, May, 529
—some roentgen aspects of pancreatic necrosis, George J. Baylin and Kenneth D. Weeks, May, 466
cysts
—pseudocysts; 3 cases (ab), Richard G. Stoll, June, 609
PAPILLOMA. See Tumors, papilloma
PARIETAL BONE
—developmental thinness of parietal bones, John D. Camp and Leo A. Nash, Jan., 42
PAROTITIS
postoperative
—with radiation treatment (ab), Daniel C. Patterson, March, 300
PASCUCCI, LUCIEN M.: Roentgen detection in an Army General Hospital of chronic diseases not excluded by induction boards, April, 375
PASTERNACK, JOSEPH G.: Calcareous pancreatitis: report of three cases with autopsies (ab), June, 608
PATTERSON, DANIEL C.: Postoperative parotitis with radiation treatment (ab), March, 300
PAUL, L. W., POHLE, E. A., and BENSON, R. R.: Oral cholecystography: a comparative study of the single- and divided-dose method with contrast media in liquid and solid form, March, 226
PAULSON, MOSES: Present position of gastroscopy in the diagnosis of gastric disease (ab), Jan., 95
PAVLOVSKY, ALFREDO: Treatment of cold abscesses by combined surgical drainage and roentgen therapy (ab), May, 526
PAYNE, FRANKLIN L. See **CHAMBERLIN, GEORGE W.**
PEARCE, ALEXANDER E.: Diagnosis of perforated ulcer. Two useful maneuvers by means of which pneumoperitoneum and diaphragmatic irritation are demonstrated more clearly (ab), April, 413
PEARL, FELIX L., and BRUNN, HAROLD: Multiple gastric polyposis. A supplementary report of 41 cases, including 3 new personal cases (ab), Jan., 96
PEDERSEN, N. S. See **BRYAN, LLOYD.**
PELVIS
See also Genitals
measurement
—analysis of roentgen pelvimetry by Johnson stereoroentgenometer in 379 cases (ab), J. N. Ané and Leon J. Menville, Jan., 101
—combined x-ray and external pelvimetry (ab), Daniel J. McSweeney and Albert M. Moloney, Feb., 210
—precision method of cephalometry and pelvimetry (ab), Paul Cave, March, 312
—relation of sacral promontory to pelvic inlet (ab), Herbert Thoms, Feb., 210
—roentgen pelvimetry: a commentary (ab), Herbert Thoms, March, 311
—roentgenographic obstetrical pelvicephalometry in the erect posture (ab), Robert P. Ball and Ross Golden, Jan., 101
roentgenography
—value of pelvioradiography in management of dystocia (ab), Arthur Weinberg and Samuel J. Scadron, March, 311
PENDERGRASS, EUGENE P., and WHITE, GEORGE: Pulmonary metastasis and pneumonitis following radiation therapy for cancer of breast (ab), May, 522
PENIS
—Peyronie's disease or plastic induration of the penis, Albert Soiland, Feb., 183
PEPTIC ULCER
—at Fort George G. Meade, Md. (ab), Charles A. Flood, April, 412
—peptic ulcers and dyspepsia in the Army (ab), Henry Tidy, June, 607
—responsibility of the roentgenologist in the wartime duodenal ulcer problem, Maurice Feldman, April, 356
perforation
—diagnosis; 2 useful maneuvers by means of which pneumoperitoneum and diaphragmatic irritation are demonstrated more clearly (ab), Alexander E. Pearce, April, 413
PERICARDITIS
—constrictive pericarditis due to Bacterium tularense. Report of case and review of reported cases of pericarditis occurring with tularemia (ab), B. V. Jager and J. C. Ransmeier, March, 303
—pericardial effusion in myxedema (ab), George T. Harrell and Christopher Johnston, March, 303
PERICARDIUM
—technic for locating and identifying pericardial and intracardiac calcifications (ab), Merrill C. Sosman, May, 512
PERINEPHRITIS
—perinephric abscess in infants and children; study of 26 patients surgically treated (ab), Henry Swan, April, 420
PERRONE, HECTOR, and WRIGHT, MYRON: Fatal case of atypical pneumonia with encephalitis (ab), Feb., 198
PERSKY, A. H.: Lymphoepithelioma of the nasopharynx. Report of case (ab), April, 421
PEYRONIE'S DISEASE
—Peyronie's disease or plastic induration of the penis, Albert Soiland, Feb., 183
PHALEN, GEORGE S., and GHORMLEY, RALPH K.: Osteopathia condensans disseminata associated with coarctation of the aorta: case report (ab), Feb., 206
PHARYNX
See also Nasopharynx
hernia
—traumatic hernia of lateral pharyngeal walls; case, Walter D. Hankins, May, 499
tumors
—lymphogranulomatosis, with secondary tumor of pharynx of similar nature (ab), N. Puente Duany, Jan., 103
PHLEBOGRAPHY. See Veins, roentgenography
PHLEBOTHROMBOSIS. See Thrombosis
PHONATION
—mechanism of phonation demonstrated by planigraphy of larynx (ab), Bruno L. Griesman, April, 406
PHOSPHORUS AND PHOSPHORUS COMPOUNDS
—solution of phosphatic calculi (with citric acid solution) (ab), Daniel J. Abramson, May, 520
radioactive. See Radioactivity
PIETRAFESA, EUGENIO R. See **SCHARER, RODOLFO F.**
PINTO, SHERMAN S., BROWN, R. ALEC, and CARLTON, B. HARDY: Study of industrial workers exposed to sulfur dust (ab) April, 409

PITUITARY BODY
diseases
—Cushing's syndrome in children. Review of literature and report of case (ab), Jason E. Farber, Francis J. Gustina, and Anthony V. Postoloff, April, 416
irradiation
—low-dosage irradiation to pituitary gland and ovaries in amenorrhea and dysfunctional uterine bleeding; a long-term survey (ab), Leon Reidenberg, Jan., 103
tumors
—adamantinoma; report of 8 cases (7 in jaw; one in pituitary body) (ab), L. K. Chont, May, 511
LACENTA
roentgenography
—localization without contrast media (ab), R. Manges Smith, Jan., 102
—study of the fetus in utero: some practical considerations, William Snow and Milton Nadel, Feb., 136
PLANIGRAPHY. See Body Section Roentgenography
PLASMOCYTES. See Bones, marrow
PNEUMOCONIOSIS
—bagasse disease of the lung (ab), W. A. Sodeman and Roscoe L. Pullen, Jan., 91
—byssinosis—report of two cases and review of literature (ab), H. Leonard Bolen, April, 409
—considerations on one thousand chest x-ray examinations performed on men applying for employment (ab), A. A. Bauer, Jan., 90
—liquefaction necrosis in bilateral symmetrical conglomerate lesions of anthraco-silicosis of lung; report of case (ab), Bernard J. McCloskey, Feb., 201
—massive conglomerate lesions of silicosis differentiated from pulmonary neoplasm (ab), Richard A. Rendich and Mortimer R. Camiel, May, 511
PNEUMOENCEPHALOGRAPHY. See Brain, roentgenography
PNEUMONIA
—acute pneumonitis (ab), Wendell G. Scott and Horace L. Jones, Jr., May, 511
—comparative roentgen study of primary atypical and bacterial pneumonia, George H. Stein and Philip J. Kresky, May, 435
—pulmonary metastasis and pneumonitis following radiation therapy for cancer of breast (ab), Eugene P. Pendergrass and George White, May, 522
—in the Army (ab), E. V. Allen and Lester W. Baird, June, 606
—inhalation pneumonia from nitric fumes, Mortimer R. Camiel and Henry S. Berkan, Feb., 175
—roentgen therapy of interstitial pneumonia (ab), Albert Oppenheimer, June, 618
atypical
—atypical (virus type) pneumonia with cor pulmonale (ab), Robert M. Woolford and Joseph H. Ogura, March, 302
—comparative roentgen study of primary atypical and bacterial pneumonia, George H. Stein and Philip J. Kresky, May, 435
—diagnosis in infancy (ab), John L. Gedgoud, Feb., 198
—discussion (ab), John W. Brown et al, Jan., 91
—fatal case with encephalitis (ab), Hector Perrone and Myron Wright, Feb., 198
—primary atypical pneumonia and malaria (ab), Edgar T. Campbell, April, 408
—primary atypical pneumonia, etiology unknown (ab), John H. Dingle et al, April, 407
—primary pneumonia; report of 200 cases at Fort Eustis, Virginia (ab), Thomas A. Campbell, Paul S. Strong, George S. Grier, III, and R. J. Lutz, Feb., 197
—roentgen diagnosis of primary atypical pneumonia, Elbert K. Lewis and Frank B. Lusk, May, 425
—roentgen study of primary atypical virus pneumonia, George Levene and Ida A. Sterman, May, 446
—virus pneumonia: etiological studies (ab), Monroe D. Eaton, April, 407
PNEUMONITIS. See Pneumonia
PNEUMOPERITONEUM
—diagnosis of perforated ulcer; 2 useful maneuvers by means of which pneumoperitoneum and diaphragmatic irritation are demonstrated more clearly (ab), Alexander E. Pearce, April, 413
—diagnostic value, J. R. Maxfield, Jr., and Albert J. McIlwain, April, 346
PNEUMOTHORAX
—in newborn infant; 3 cases (ab), G. W. Salmon and G. B. Forbes, June, 605
POHLE, ERNST A., and BENSON, ROLAND R.: Radiation therapy in cancer of the esophagus: analysis of 85 cases observed during the last decade (ab), Feb., 211
——See PAUL, L. W.
POLIOMYELITIS
—paralytic scoliosis (ab), Aladár Farkas, Feb., 207
POLYCYTHEMIA
—cavernous hemangioma of lung; secondary polycythemia (ab), Alfred Goldman, June, 606
therapy
—radio-phosphorus; an agent for the satisfactory treatment of polycythemia and its associated manifestations; report of case of polycythemia secondary possibly to Banti's syndrome (ab), Lowell A. Erf and Harold W. Jones, May, 526
POLYPI. See Tumors, polypi
POOL, H. H.: Roentgen therapy with low dosage in suppurative infections, March, 255
POPP, WALTER C. See **CURRENS, JAMES H.**
PORENCEPHALY. See Brain, cysts
POSEL, M. M. See **HEIMANN, H. L.**
POSTOLOFF, ANTHONY V. See **FARBER, JASON E.**
POWER, HOWARD A.: Comparative value of roentgen versus clinical methods of pelvic examination in obstetrics: clinical aspects (ab), Jan., 102
PRATHER, GEORGE C.: Urethrograms in urethral strictures: valuable aid in determining type of treatment (ab), March, 313
PREGNANCY
complications
—leukemia and pregnancy: case report and review of literature (ab), J. L. McGoldrick and Warren A. Lapp, June, 617
roentgenography. See also Pelvis, measurement; Placenta roentgenography
—comparative value of roentgen versus clinical methods of pelvic examination in obstetrics: clinical aspects (ab), Howard A. Power, Jan., 102
—comparative value of roentgen versus clinical methods of pelvic examination in obstetrics: roentgenologic aspects (ab), Samuel G. Henderson, Jan., 101
tumors complicating
—cysts of spleen (with report of case) (ab), John W. Snyder and Philipp R. Rezek, Jan., 98
PRIESTLEY, JAMES T. See **WEISEL, WILSON**
PRIODAX. See Gallbladder, roentgenography
PROCTOR, D. T.: X-raying of school personnel (ab), Feb., 199
PROSTATE
tumors
—retothel sarcoma; case (ab), Jack D. Kirshbaum, Herbert S. Larkin, and Harry Culver, June, 615
PRURITUS
—roentgen therapy in ano-vulvar pruritus (ab), José Luis Molinari and Aníbal Lemos Ibáñez, May, 526
PUBIC BONE
fractures
—march fracture or insufficiency fracture (ab), Samuel H. Nickerson, June, 611
PUENTE DUANY, N.: Lymphogranulomatosis, with a secondary tumor of the pharynx of similar nature (ab), Jan., 103
——and FIGUERAS GONZÁLES, W.: Carcinoma of the lung, with freedom from symptoms for five years (ab), Jan., 103
PYELITIS
—radiopaque membranous pyelitis following sulfonamide therapy (ab), Payson Adams, April, 419
PYELOGRAPHY
—estimation of renal function based on specific gravity changes following intravenous urography (ab), George O. Baumrucker, May, 518
—layer formation (ab), Alice Ettinger, Jan., 102
—renal ectopia; report of 2 cases with new method of x-raying pelvic ectopia (ab), Nicholas S. Scarcello, May, 519
—value of delayed examination, Ellis C. Osgood, April, 380
PYLE, IDELL, and SONTAG, L. W.: Variability in onset of ossification in epiphyses and short bones of the extremities (ab), Jan., 98
PYLORUS
hypertrophy and stenosis
—radiologic sign of pyloric stenosis (ab), A. S. Johnstone, Feb., 202

Q

QUASTLER, HENRY: Depth dose measurements in contact roentgen therapy on a biological test object (rabbit's skin) (ab), June, 614
QUEEN, FRANK B. See **KERNWEIN, GRAHAM A.**
QUIMBY, EDITH H., and FOCHT, ELIZABETH F.: Dosage measurements in contact roentgen therapy (ab), June, 614

R

RADIOACTIVITY
—elimination of administered zinc in pancreatic juice, duodenal juice, and bile of dog as measured by its active isotope (Zn^{65}) (ab), M. Laurence Montgomery, G. E. Sheline, and I. L. Chaikoff, May, 529
—metabolism of bone salts in resistant rickets; report of case, with balance and radioactive tracer studies (ab), Lewis Gunther, Elma T. Cohn, Waldo E. Cohn, and David M. Greenberg, June, 611
—radioactive iodine studies in childhood hypothyroidism (ab), Joseph G. Hamilton, Mayo H. Soley, William A. Reilly, and Karl B. Eichorn, June, 604
—radioactive phosphate as indicator of relationship between phosphate changes of blood, muscle, and liver, following administration of insulin (ab), Nathan O. Kaplan and David M. Greenberg, May, 529
—radio-phosphorus; an agent for the satisfactory treatment of polycythemia and its associated manifestations; report of case of polycythemia secondary possibly to Banti's syndrome (ab), Lowell A. Erf and Harold W. Jones, May, 526
—study with radioactive isotopes of permeability of blood-cerebrospinal fluid barrier to ions (ab), David M. Greenberg, et al, May, 529
RADIOLOGICAL SOCIETIES
—American Roentgen Ray Society, Jan., 84
—Chicago Roentgen Society, May, 504
—officers and meeting dates, Jan., 86; Feb., 192; March, 296; April, 402; May, 506; June, 601
—Pennsylvania Radiological Society, March, 293

RADIOLOGICAL SOCIETIES—*cont.*
—Radiological Section, Los Angeles County Medical Association, March, 293
—San Diego Roentgen Society, Feb., 190
RADIOLOGICAL SOCIETY OF NORTH AMERICA
—announcing a joint meeting of the Radiological Society of North America and the American Roentgen Ray Society (ed), March, 289
—joint meeting of Radiological Society of North America and the American Roentgen Ray Society, April, 399
—presidential address; Twenty-ninth Annual Meeting of the Radiological Society of North America, Robert S. Stone, March, 290
—report of Twenty-ninth Annual Meeting (business session), Chicago, Jan., 85
RADIOTHERAPY
See also Radium, therapy; Roentgen Therapy
—local application of sulfanilamide powder in radiotherapy (ab), Alexander A. Charteris, June, 615
—the future; radiological services (ab), May, 530
RADIUM
injurious effects
—new type of radium loading protective device (ab), Andrew H. Dowdy, Benjamin DuBilier, and Dean B. Cowie, Jan., 104
—prevention and control of hazards in radium dial painting industry (ab), L. F. Curtiss, March, 318
—protection of radium dial painters—specific work habits and equipment (ab), George E. Morris, Irving R. Tabershaw, John B. Skinner, and Manfred Bowditch, March, 318
—protection of radium dial workers and radiologists from injury by radium (ab), Robley D. Evans, March, 318
—radiodermatitis of head and neck with discussion of its surgical treatment (ab), F. A. Figi, G. B. New, and C. R. Dix, May, 527
—storage of radium dial instruments (ab), Charles R. Williams and Robley D. Evans, March, 318
—ventilation requirements for radium dial painters (ab), W. C. L. Hemeon and Robley D. Evans, March, 318
therapy
—nomographic aids in calculating radium dosage for plane and point sources, Bernard S. Wolf, April, 368
RADIUS
—congenital retardation in development of carpal navicular, first metacarpal, and styloid process of radius (ab), A. R. Hodgson, Feb., 206
RANSMEIER, J. C. See **JAGER, B. V.**
von RECKLINGHAUSEN'S DISEASE
neurofibromatosis. See Neurofibromatosis
osteitis fibrosa. See Osteitis fibrosa
RECRUITS
See also Military Medicine and Surgery
—roentgen detection in an Army General Hospital of chronic diseases not excluded by induction boards, Lucien M. Pascucci, April, 375
RECTUM
—foreign body (bottle) in rectum; case, Stanley H. Macht, May, 500
cancer
—Norman A. McCormick, June, 531
—clinical features, diagnosis and treatment of carcinoma of colon and rectum, David S. Beilin, June, 539
—results of treatment of 173 cases of carcinoma, M. Malbin and K. Wilhelm Stenstrom, June, 545
—spread of carcinoma; invasion of lymphatics, veins and nerves (ab), Philip H. Seefeld and J. Arnold Bargen, March, 307
tumors. See also Rectum, cancer
—endometriosis; study of 117 cases with special reference to constricting lesions of rectum and sigmoid colon (ab), E. L. Jenkinson and W. H. Brown, Jan., 97
REDLER, IRVING: Fractures of the neck of the metacarpal (ab), Feb., 209
REIDENBERG, LEON: Low-dosage irradiation to the pituitary gland and ovaries in amenorrhea and dysfunctional uterine bleeding: a long-term survey (ab), Jan., 103
REILLY, WILLIAM A. See **HAMILTON, JOSEPH G.**
REINHARD, M. C., and GOLTZ, H. L.: Million-volt isodose curves for angulated beams, June, 591
RENDICH, RICHARD A., and CAMIEL, MORTIMER R.: Massive conglomerate lesions of silicosis differentiated from pulmonary neoplasm (ab), May, 511
RESPIRATION
—importance of wheeze in diagnosis of pulmonary tuberculosis (ab), John S. Packard, Feb., 200
RESPIRATORY TRACT
See also Bronchi; Lungs; Nasopharynx; etc.
—interrelationship of upper and lower respiratory infections, emphasizing routes of infection (ab), John G. McLaurin, April, 406
RETICULOSARCOMA. See Sarcoma, reticulosarcoma
RETINA
tumors
—treatment of retinoblastoma. Radiation therapy supplementing surgical treatment, Galen M. Tice and E. J. Curran, Jan., 20
REZEK, PHILIPP R. See **SNYDER, JOHN W.**
RHABDOMYOSARCOMA. See Sarcoma, myosarcoma
RIBS
fractures
—anomalous origins of posterior intercostal arteries from 915 thoracic aortas; their role in fractures of ribs (ab), Myrtelle M. Canavan, May, 513
—isolated fracture of first rib produced by muscular traction; case, Robert L. Garber, April, 395
RICKETS
—metabolism of bone salts in resistant rickets: report of case, with balance and radioactive tracer studies (ab), Lewis Gunther, Elma T. Cohn, Waldo E. Cohn, and David M. Greenberg, June, 611
—renal dwarfism or renal rickets (ab), Robert C. Moehlig, June, 612
RIGLER, LEO G., and HALLOCK, PHILLIP: Chronic cor pulmonale (ab), May, 512
RIGOS, FRANK J., and KIRKLIN, B. R.: Diagnostic roentgenology in gastroenterology for the year 1941 (ab), April, 416
Review of the gastro-enterologic diagnostic roentgenologic literature for the year 1942 (ab), April, 416
RILANCE, ARNOLD B., and GERSTL, BRUNO: Bronchiectasis secondary to pulmonary tuberculosis (ab), Feb., 200
RIVER, LOUIS P., and GRADINGER, BILLENS C.: Appendiculocolic fistula. Case report (ab), April, 415
ROBB, GEORGE P. See **RUSKIN, ARTHUR**
ROBBERSON, JASON H.: Fallopian tube visualization (ab), May, 518
ROBBINS, LAURENCE L.: Roentgenologic appearance of "bronchiogenic" cysts (ab), April, 408
Roentgenologic demonstration of spinal metastases from leiomyosarcoma of uterus (ab), June, 613
ROBERTSON, JAMES E.: Metabolic changes occurring as result of deep roentgen therapy: II. Effect of 1,000 kilovolt roentgen therapy (ab), May, 527
ROBINOW, MEINHARD, JOHNSTON, MARGARET, and ANDERSON, MARGARET: Feet of normal children; study of lateral x-rays of the weight-bearing foot (ab), June, 610
ROENTGEN RAYS
apparatus
—adaptor for fluoroscopic depth localization (ab), Leo Mackta, May, 521
—x-ray equipment; revision of limitation order, Jan., 84
diagnosis. See also Pneumoperitoneum
—optimum kilovoltage technic in military roentgenography (ab), Arthur W. Fuchs, May, 522
—roentgen detection in an Army General Hospital of chronic diseases not excluded by induction boards, Lucien M. Pascucci, April, 375
—the future; radiological services (ab), May, 530
effects. See also Abortion, therapeutic; Roentgen Rays, injurious effects
—on aqueous solutions of biologically active compounds (ab), Walter M. Dale, April, 424
—on cell-virus associations; findings with virus-induced rabbit papillomas and fibromas (ab), Wm. F. Friedewald and Rubert S. Anderson, May, 529
films
—reciprocity law failure in x-ray films, Russell H. Morgan, May, 471
fluoroscopy
—critical and casuistic contribution on the theme "fluoroscopy in the Army" (ab), H. H. Weber, Jan., 90
—new apparatus for stereoscopic fluoroscopy: the stereoroentgenoscope. Orthodiagraphy with stereoroentgenoscope (ab), Max Hopf, March, 304
—results of systematic fluoroscopy of an Army Unit on relief from service (ab), C. Frei, Jan., 90
injurious effects
—effect of heparinization on experimental post-irradiation tissue changes in lung; preliminary study (ab), Floyd Boys and Ivor D. Harris, Jan., 104
—induction of leukemia in mice by methylcholanthrene and x-rays (ab), D. P. McEndy, Mary C. Boon, and Jacob Furth, Jan., 104
—pulmonary metastasis and pneumonitis following radiation therapy for cancer of breast (ab), Eugene P. Pendergrass and George White, May, 522
—radiodermatitis of head and neck with discussion of its surgical treatment (ab), F. A. Figi, G. B. New, and C. R. Dix, May, 527
—response of cells in vitro to variations in dosage (ab), Ilse Lasnitzki, April, 424
—tissue changes produced in C3H mice by 50 r whole body exposure, A. Nettleship, Jan., 64
—treatment of post-irradiation erythema with chlorophyll ointment (ab), George W. Holmes and H. Peter Mueller, March, 318
protection against
—results of photographic estimation of stray x radiation received by hospital x-ray personnel (ab), L. H. Clark and D. E. A. Jones, April, 424
stereoscopy
—determination of the position of calcium deposits and foreign bodies from stereoscopic films without the use of a viewing stereoscope, Sam Levi, Jan., 71
—new apparatus for stereoscopic fluoroscopy; the stereoroentgenoscope. Orthodiagraphy with stereoroentgenoscope (ab), Max Hopf, March, 304
ROENTGEN THERAPY
—low-voltage contact irradiation: further experience, Lowell S. Goin, March, 241
—minor therapy (ab), Sydney J. Hawley, May, 525
—tissue changes produced in C3H mice by 50 r whole body exposure, A. Nettleship, Jan., 64

ROENTGEN THERAPY—*cont.*
dosage
—depth dose measurements for 100-, 120-, and 135-kv. roentgen rays, Carl B. Braestrup, March, 258
—depth dose measurements in contact therapy on biological test object (rabbit's skin) (ab), Henry Quastler, June, 614
—dosage measurements in contact therapy (ab), Edith H. Quimby and Elizabeth F. Focht, June, 614
high-voltage
—metabolic changes occurring as result of deep roentgen therapy: I. Effect of 200 kilovolt roentgen therapy (ab), Douglas Goldman, May, 527
—metabolic changes occurring as result of deep roentgen therapy: II. Effect of 1,000 kilovolt roentgen therapy (ab), James E. Robertson, May, 527
—supervoltage roentgen therapy of esophageal carcinoma, Franz Buschke and Simeon T. Cantril, May, 480
—million-volt isodose curves for angulated beams, M. C. Reinhard and H. L. Goltz, June, 591
ROENTGENOGRAMS. See Roentgen Rays, films
ROENTGENOLOGY
—significance of close co-operation between roentgenologist and internist (ab), Herbert Ludwig, Feb., 211
ROSENTHAL, JULIUS. See **FEIGIN, IRWIN**
ROSENTHAL, LOUIS M. See **HOLVEY, ERVIN H.**
ROTHMAN, MILTON, BRUCKNER, JOHN P., and ZETENA, DOMINICK, F.: Volvulus of the cecum and ascending colon, with review of literature and presentation of case (ab), May, 514
ROWE, EDWARD W., and FRAZER, MAURICE D.: Roentgen therapy of Wilms' tumor, Feb., 107
ROWLAND, DRIVER: Cardiac aneurysm: report of a case with correlation of clinical, radiological and electrocardiographic findings (ab), March, 304
ROYCE, G. B. See **ALLISON, P. R.**
RUSKIN, ARTHUR, TARNOWER, HERMAN, LATTIN, BERTON, and ROBB, GEORGE P.: Isolated dextrocardia, with diodrast studies (ab), March, 303

S

SACRUM
—anterior sacral meningocele (ab), Frederick A. Coller and Richard G. Jackson, Jan., 99
SALE, ONAL ARTHUR (obit), May, 504
SALMON, D. D.: Hereditary cleidocranial dysostosis, April, 391
SALMON, G. W., and FORBES, G. B.: Pneumothorax in the newborn infant: report of three cases (ab), June, 605
SAMPSON, JOHN J.: An apparent causal mechanism of primary thrombosis of the axillary and subclavian veins (ab), March, 314
SARCOMA
—giant-cell tumor of the lower femur. Case report with roentgen and pathological findings before and after curettage and roentgen therapy with amputation for sarcoma, F. B. Mandeville and John S. Howe, Jan., 56
etiology and pathogenesis
—trauma and malignancy (ab), William J. Carson, March, 314
Ewing's. See Tumors, Ewing's
leiomyosarcoma. See Sarcoma, myosarcoma
lymphosarcoma
—of stomach (ab), Harry Yarnis and Ralph Colp, June, 615
—primary lymphosarcoma of intestine in boy of seven. Follow-up of nine years (ab), Herman Charache, March, 317
metastases
—roentgenologic demonstration of spinal metastases from leiomyosarcoma of uterus (ab), Laurence L. Robbins, June, 613
myosarcoma
—rhabdomyosarcoma of extremities; case, Robert L. Garber, June, 595
—roentgenologic demonstration of spinal metastases from leiomyosarcoma of uterus (ab), Laurence L. Robbins, June, 613
neurosarcoma
—solitary neurogenic sarcoma of mesentery; review of literature and report of case (ab), Morris J. Shapiro and Moris Horwitz, April, 416
osteosarcoma
—osteogenic sarcoma: I. Modified nomenclature and review of 118 five year cures (ab), Ian Macdonald and John W. Budd, May, 524
—treatment of osteogenic sarcoma with preoperative roentgen radiation in large doses, Robert F. McNattin, March, 246
reticulosarcoma
—retothel sarcoma of prostate gland; case (ab), Jack D. Kirshbaum, Herbert S. Larkin, and Harry Culver, June, 615
retotheliosarcoma. See Sarcoma, reticulosarcoma
synovial. See Synovial Membrane, tumors
SARTWELL, PHILIP E.: Roentgenographic surveys for tuberculosis in Massachusetts and their importance to the physician (ab), Feb., 199
SAUER, HANS R. See **HERGER, CHARLES C.**
SCADRON, SAMUEL J. See **WEINBERG, ARTHUR**
SCAPHOID BONE, CARPAL
—congenital retardation in development of carpal navicular, first metacarpal, and styloid process of radius (ab), A. R. Hodgson, Feb., 206
SCAPULA
—etiology of undescended scapula and related syndromes (ab), D. Engel. Feb., 205
SCARCELLO, NICHOLAS S.: Renal ectopia: report of two cases with a new method of x-raying pelvic ectopia (ab), May, 519
SCHARER, RODOLFO F., and PIETRAFESA, EUGENIO R.: An original observation: "Accordion heart" caused by anemia (ab), June, 607
SCHATTENBERG, HERBERT J., and HARRIS, WILLIAM H., Jr.: Aortic aneurysm with rupture into the pulmonary artery (ab), March, 305
SCHATZKI, RICHARD: Symposium on the management of the Cocoanut Grove burns at the Massachusetts General Hospital. Roentgenologic report of the pulmonary lesions (ab), March, 301
SCHEFFEY, L. C., and HAHN, G. A.: Inadequate and ill-advised surgery in the treatment of carcinoma of the cervix (ab), Feb., 212
SCHNEEBERG, NORMAN G. See **EDEIKEN, LOUIS**
SCHOOLS
—x-raying of school personnel (ab), R. R. Newell, Feb., 199
—x-raying of school personnel (ab), D. T. Proctor, Feb., 199
SCHROEDER, G. F. See **DeBAKEY, M. E.**
SCHÜLLER-CHRISTIAN SYNDROME
—xanthomatosis—Hand-Schüller-Christian type: report of a case with pulmonary fibrosis (ab), James H. Currens and Walter C. Popp, Jan., 92
SCHULLER, ARTHUR: Note on the identification of skulls by x-ray pictures of the frontal sinuses (ab), Feb., 196
SCHWARTZ, CHARLES W.: Pitfalls to be avoided in the roentgen diagnosis of intracranial disease, Jan., 34
SCLERODACTYLIA. See Scleroderma
SCLERODERMA
—disabling changes in hands resembling sclerodactylia following myocardial infarction (ab), Alf C. Johnson, April, 419
SCOLIOSIS. See Spine, curvature
SCOTT, H. WILLIAM, Jr. See **INGRAHAM, FRANC D.**
SCOTT, WENDELL G., and JONES, HORACE L., Jr.: Acute pneumonitis (ab), May, 511
SCURVY
—infantile scurvy; case report with follow-up roentgenogram of pre-existent healed scurvy (ab), Daniel Blitz, June, 611
SEEFELD, PHILIP H., and BARGEN, J. ARNOLD: Spread of carcinoma of the rectum: invasion of lymphatics, veins and nerves (ab), March, 307
SELL, L. STANLEY. See **O'DONOGHUE, D. H.**
SELZER, G. See **ZIADY, F.**
SEMINAL VESICLES
—retrograde vesiculography (ab), Fernan Gonzales-Iman, March, 313
SEMINOMA. See Tumors, seminoma
SERBY, A. M., and LICHTENSTEIN, GEMMA M.: Study of the significance and accuracy of cholecystographic findings (ab), March, 308
SHACKELFORD, RICHARD T., and BROWN, WEBSTER H.: Osteochondroma of the coronoid process of the mandible (ab), Feb., 197
SHAPIRO, MORRIS J., and HORWITZ, MORIS: Solitary neurogenic sarcoma of the mesentery. Review of literature and report of case (ab), April, 416
SHAPIRO, ROBERT: "Mitralization" of the cardiovascular silhouette in the posteroanterior roentgenogram (ab), Feb., 201
SHELINE, G. E. See **MONTGOMERY, M. LAURENCE**
SHINALL, HAROLD L.: Roentgen diagnosis of bronchiogenic carcinoma, March, 213
SHOLLENBERGER, C. L. See **AGERTY, H. A.**
SHOULDER
See also Scapula
—arthritis of acromioclavicular joint (ab), Albert Oppenheimer, May, 516
—roentgen treatment of acute bursitis (ab), John H. Harris, April, 423
pain
—diagnosis of perforated ulcer; 2 useful maneuvers by means of which pneumoperitoneum and diaphragmatic irritation are demonstrated more clearly (ab), Alexander E. Pearce, April, 413
tumors
—primary malignant neoplasm of shoulder joint, with report of case, Harry A. Olin, April, 359
—rhabdomyosarcoma of extremities; case, Robert L. Garber, June, 595
SIGMOID
See also Colon
—sigmoiditis (ab), Stephen L. Casper, Feb., 203
stricture. See Sigmoid, tumors
tumors
—endometriosis; study of 117 cases with special reference to constricting lesions of rectum and sigmoid colon (ab), E. L. Jenkinson and W. H. Brown, Jan., 97
SILICOSIS. See Pneumoconiosis
SINUSES, PARANASAL
diseases
—interrelationship of upper and lower respiratory infections, emphasizing routes of infection (ab), John G. McLaurin, April, 406
SKATING
—ice skater's fracture; a form of fatigue fracture (ab), C. F. Ingersoll, May, 515
SKIN
effects of radiation on. See Roentgen Rays, injurious effects
SKINNER, JOHN B. See **MORRIS, GEORGE E.**

SKULL. See Cranium
SLOBODY, LAWRENCE B. See **FREUD, PAUL**
SMITH, CLEMENT A. See **MENEGHELLO, JULIO**
SMITH, GEORGE G.: Tumors of the testicle: analysis of results obtained in 50 patients treated by x-ray therapy (ab), June, 616
SMITH, JAMES H.: Loeffler's syndrome (ab), Jan., 91
SMITH, R. MANGES: Roentgenologic localization of the placenta without contrast media (ab), Jan., 102
SMITH, THOMAS T. See **HERBUT, PETER A.**
SNOW, WILLIAM, and NADEL, MILTON: Roentgen study of fetus in utero: some practical considerations, Feb., 136
SNYDER, JOHN W., and REZEK, PHILIPP R.: Cysts of the spleen (ab), Jan., 98
SODEMAN, W. A., and PULLEN, ROSCOE L.: Bagasse disease of the lung (ab), Jan., 91
SOILAND, ALBERT: Peyronie's disease or plastic induration of the penis, Feb., 183
SOLDIERS. See Military Medicine and Surgery; Recruits
SOLEY, MAYO H. See **HAMILTON, JOSEPH G.**
SOMERVILLE, E. W.: Air arthrography in the diagnosis of internal derangement of the knee-joint (ab), May, 516
SONTAG, LESTER W., and LIPFORD, JANET: Effect of illness and other factors on the appearance pattern of skeletal epiphyses (ab), June, 610
——See **PYLE, IDELL**
SOSMAN, MERRILL C.: Technique for locating and identifying pericardial and intracardiac calcifications (ab), May, 512
——See **DONOVAN, MARK S.**
SPEIGEL, IRVING J. See **BUCY, PAUL C.**
SPENCER, R. R.: Place of National Cancer Institute in cancer program, May, 493
SPINA BIFIDA
—spina bifida and cranium bifidum: Arnold-Chiari malformation: study of 20 cases (ab), Franc D. Ingraham and H. William Scott, Jr., Feb., 196
—spina bifida and cranium bifidum: unusual nasopharyngeal encephalocele (ab), Franc D. Ingraham and Donald D. Matson, Feb., 196
SPINAL CANAL ROENTGENOGRAPHY
—unusual complication of intraspinal use of iodized oil (ab), Paul C. Bucy and Irving J. Speigel, April, 420
SPINAL CORD
compression
—hemangioma of vertebra with compression of cord; report of case cured with radiation fourteen years ago (ab), L. Minor Blackford, May, 524
SPINE
—brucella spondylitis; case (ab), Martin Dobelle, May, 516
abnormalities
—development of vertebral column as related to certain congenital and pathological changes (ab), J. L. Ehrenhaft, Jan., 98
arthritis
—ankylosing spondylarthritis: Marie-Strümpell arthritis. Roentgen and orthopedic therapy (ab), Lenox D. Baker, Feb., 207
—differential diagnosis in young subjects (ab), C. W. Buckley, Feb., 207
—x-ray treatment of ankylosing spondylitis (ab), Gwen Hilton, May, 526
curvature
—paralytic scoliosis (ab), Aladár Farkas, Feb., 207
dislocations
—spondylolisthesis: general consideration with emphasis on radiologic aspects, A. C. Galluccio, Feb., 143
intervertebral disks
—herniation of nucleus pulposus as complication of pre-existing low back instability (ab), E. M. Deery, Feb., 208
—protruded disks (ab), J. Grafton Love and Maurice N. Walsh, June, 610
—recent advances in treatment of ruptured (lumbar) intervertebral disks (ab), Walter E. Dandy, May, 515
roentgenography. See other subheads under Spine
syphilis
—spondylitis (ab), Eugene Freedman and I. Meschan, Jan., 99
tumors
—hemangioma of vertebra with compression of cord; report of case cured with radiation fourteen years ago (ab), L. Minor Blackford, May, 524
—roentgenologic demonstration of spinal metastases from leiomyosarcoma of uterus (ab), Laurence L. Robbins, June, 613
SPLEEN
cysts
—(ab), John W. Snyder and Philipp R. Rezek, Jan., 98
—single true cysts; 3 cases (ab), Richard H. Sweet, Feb., 204
SPONDYLITIS. See Spine
SPONDYLOLISTHESIS. See Spine, dislocations
STEIN, GEORGE H., and KRESKY, PHILIP J.: Comparative roentgen study of primary atypical and bacterial pneumonia, May, 435
STEIN, ROBERT J.: "Silent" skeletal metastases in cancer (ab), June, 613
STEINBERG, ISRAEL. See **GREENFIELD, IRVING**
STEINBERG, M. F., GRISHMAN, A., and SUSSMAN, M. L.: Angiocardiography in congenital heart disease: intracardiac shunts (ab), Jan., 93
Angiocardiography in congenital heart disease: patent ductus arteriosus (ab), April, 411
——See **SUSSMAN, M. L.**
STENSTROM, E. WILHELM. See **BIXLER, LOUIS C.**
——See **MALBIN, M.**
STEPHENS, ROBERT L. See **KERR, H. DABNEY**
STEREOROENTGENOMETER. See Pelvis, measurement
STEREOSCOPY. See Roentgen Rays, stereoscopy
STERMAN, IDA A. See **LEVENE, GEORGE**
STEVENSON, WALTER. See **NEW, GORDON B.**
STOLL, RICHARD G.: Pseudocysts of the pancreas: report of three cases (ab), June, 609
STOMACH
cancer
—duration (ab), Walter L. Palmer, April, 414
—mistakes and misunderstandings in roentgenologic diagnosis (ab), B. R. Kirklin, Jan., 95
cardiospasm
—carcinoma of esophagus in association with achalasia of cardia, S. R. Bersack, March, 220
diverticula
—(ab), Martin L. Tracey, April, 413
gastroscopy
—present position of gastroscopy in diagnosis of gastric disease (ab), Moses Paulson, Jan., 95
—problems in gastric diagnosis; the gastroscope as supplementary aid to x-ray examination (ab), Allan L. Cohn and Joseph Levitin, May, 513
hernia
—at esophageal hiatus (ab), John W. Turner, Feb., 202
—treatment of dysphagia from hernia through esophageal hiatus in diaphragm (ab), Porter P. Vinson, April, 412
motility
—emptying time of normal human stomach in young adult (ab), Edward J. Van Liere and David W. Northup, April, 412
roentgenography
—problems in gastric diagnosis; the gastroscope as supplementary aid to x-ray examination (ab), Allan L. Cohn and Joseph Levitin, May, 513
tumors. See also Stomach, cancer
—fibroma; case (ab), H. M. Wiley, Jan., 96
—lymphosarcoma (ab), Harry Yarnis and Ralph Colp, June, 615
—multiple polyposis; supplementary report of 41 cases, including 3 new personal cases (ab), Felix L. Pearl and Harold Brunn, Jan., 96
ulcers. See Peptic Ulcer
STONE, SAMUEL: Osteomyelitis of the long bones in the newborn (ab), Jan., 99
STORR, N. V., and KEEN, P.: von Recklinghausen's neurofibromatosis (ab), April, 418
STRONG, PAUL S. See **CAMPBELL, THOMAS A.**
SULFANILAMIDE AND SULFANILAMIDE DERIVATIVES
—local application of sulfanilamide powder in radiotherapy (ab), Alexander A. Charteris, June, 615
—radiopaque membranous pyelitis following sulfonamide therapy (ab), Payson Adams, April, 419
SULFUR
—study of industrial workers exposed to sulfur dust (ab), Sherman S. Pinto, R. Alec Brown, and B. Hardy Carlton, April, 409
SUPRARENALS. See Adrenals
SUSSMAN, M. L., GRISHMAN, A., and STEINBERG, M. F.: Roentgenologic diagnosis of right-sided enlargement of the heart (ab), Feb., 201
——See **STEINBERG, M. F.**
SWALLOWING. See Deglutition
SWAN, HENRY: Perinephric abscess in infants and children; a study of 26 patients surgically treated (ab), April, 420
SWEET, RICHARD H.: Single true cysts of the spleen: report of 3 cases (ab), Feb., 204
SWENSON, PAUL C.: Roentgenologic aspects of Ewing's tumor of bone marrow (ab), April, 417
SYMPHALANGISM
—symphalangism, a familial malformation (ab), Paul Freud and Lawrence B. Slobody, April, 417
SYNOSTOSIS
—congenital talonavicular synostosis; case report of rare anomaly (ab), D. H. O'Donoghue and L. Stanley Sell, May, 517
SYNOVIAL MEMBRANE
cysts
—Baker's cyst: posterior herniation of knee joint, Harold H. Kuhn and James E. Hemphill, March, 237
—posterior hernia of knee (Baker's cyst, popliteal cyst, semimembranosus bursitis, medial gastrocnemius bursitis and popliteal bursitis) (ab), Henry W. Meyerding and Robert E. VanDemark, Feb., 208
tumors
—hemangioma of synovial membrane of knee joint cured by synovectomy (ab), Paul H. Harmon, May, 516
—synovioma involving the knee joint; case (ab), Malcolm S. Eveleth and Philip S. Brezina, May, 516
SYNOVIOMA. See Synovial Membrane, tumors

T

TABERSHAW, IRVING R. See **MORRIS, GEORGE E.**
TABES DORSALIS
—arthropathy and osteopathy in tabetic arthropathy of the hip; case, Irving Wolin, Jan., 79
TAGLIA, VITO. See **FOX, NOAH**
TALONAVICULAR JOINT. See Ankle

TAMARKIN, SAUL J.: X-ray therapy of benign uterine bleeding and fibromyoma (ab), June, 616
TARNOWER, HERMAN. See **RUSKIN, ARTHUR**
TAUSSIG, HELEN B. See **BAER, RIDGELY W.**
TAYLOR, HENRY K.: Aseptic necrosis in adults: caisson workers and others, June, 550
TECHNICIANS
—training of x-ray technicians at the School for Medical Department Enlisted Technicians, W. W. McCaw, April, 384
TEMPORAL BONE
—delayed ossification (in infant with meningitis) (ab), Hans Brunner and H. James Hara, Feb., 205
TERHUNE, SAMUEL R., and EDDLEMAN, THOMAS S.: Double march fracture; case report (ab), May, 515
TESTES
—regenerative processes induced by gonadotropic hormones in irradiated testes of albino rat, Emanuele Momigliano and J. M. Essenberg, March, 273
tumors
—analysis of 50 cases treated by x-ray therapy (ab), George G. Smith, June, 616
—seminoma from standpoint of roentgen treatment (ab), Leo A. Nash and Eugene T. Leddy, March, 316
TETRALOGY OF FALLOT. See Heart, abnormalities
THOMAS, M. E., and GARBER, A. ELIZABETH: Two cases of dissecting aneurysm of the aorta, with ante-mortem diagnosis (ab), March, 304
THOMAS, MORRIS C.: Types of lung diseases encountered in an army camp (ab), Feb., 197
THOMS, HERBERT: Relation of the sacral promontory to the pelvic inlet (ab), Feb., 210
Roentgen pelvimetry: A commentary (ab), March, 311
THORAX
See also Heart; Lungs; Mediastinum; etc.
roentgenography. See also Tuberculosis, Pulmonary, mass roentgenologic surveys
—control of diagnostic quality (ab), Russell H. Morgan, March, 300
THORNTON, T. F., Jr. See **ADAMS, W. E.**
THROAT
See also Larynx; Pharynx; etc.
cancer
—diagnosis of cervical metastasis from squamous carcinoma (ab), C. A. Whitcomb, March, 300
THROMBOPHLEBITIS. See Thrombosis
THROMBOSIS
—significance of phlebography in phlebothrombosis (ab), M. E. DeBakey, G. F. Schroeder, and A. Ochsner, June, 614
axillary
—apparent causal mechanism of primary thrombosis of axillary and subclavian veins (ab), John J. Sampson, March, 314
—thrombosis of subclavian and axillary veins; report of 46 cases (ab), James R. Veal and Hugh H. Hussey, March, 314
coronary
—heart size and pulmonary findings during acute thrombosis (ab), Edward Massie and Wallace C. Miller, April, 410
subclavian
—apparent causal mechanism of primary thrombosis of axillary and subclavian veins (ab), John J. Sampson, March, 314
—thrombosis of subclavian and axillary veins; report of 46 cases (ab), James R. Veal and Hugh H. Hussey, March, 314
THYMUS
tumors
—in myasthenia gravis; case (ab), Elmer Haynes, April, 410
THYROID
hypothyroidism
—radioactive iodine studies in childhood hypothyroidism (ab), Joseph G. Hamilton, Mayo H. Soley, William A. Reilly, and Karl B. Eichorn, June, 604
TIBIA
cancer
—epidermoid carcinoma; 2 cases (ab), Ernest Kraft, June, 612
diseases
—eosinophilic granuloma; case (ab), Thomas Horwitz, April, 418
fractures
—pin distraction as cause of non-union (ab), Arthur G. Davis, Feb., 209
TICE, GALEN M., and CURRAN, E. J.: Treatment of retinoblastoma. Radiation therapy supplementing surgical treatment, Jan., 20
TIDY, HENRY: Peptic ulcers and dyspepsia in the army (ab), June, 607
TILDEN, IRVIN L. See **HARTWELL, ALFRED S.**
TISSUE
—changes produced in C3H mice by 50 r whole body exposure, A. Nettleship, Jan., 64
TOMLINSON, WRAY J., and WOLFF, ERNEST: Primary liver-cell carcinoma in infancy. Report of 2 cases, one showing calcification (ab), April, 416
TOMOGRAPHY. See Body Section Roentgenography
TONSILS
tumors
—sarcoma; impressions made by 7 cases (ab), C. A. Whitcomb, April, 406
TOTH, BENEDICT J.: Accidental trauma and tumor metastases, June, 579
TOUROFF, ARTHUR S. W. See **GREENFIELD, IRVING**
TOWSLEY, HARRY A. See **HAIGHT, CAMERON**
TRABUCCO, ARMANDO: Some radiologic findings and anatomopathological results of experimental renal trauma (ab), March, 312
TRACEY, MARTIN L.: Gastric diverticula (ab), April, 413
TRACHEA
tuberculosis
—tuberculous tracheobronchitis (ab), David McCullough, April, 407
TRAUMA
—accidental trauma and tumor metastases, Benedict J. Toth, June, 579
—trauma and malignancy (ab), William J. Carson, March, 314
TRIPODI, ANTONIO M., and KRUGER, ALFRED L.: Appendiceal lithiasis (ab), April, 415
TUBERCULOSIS
See also Tuberculosis, pulmonary, and under names of organs
—lymphogranulomatosis and tuberculosis (ab), André Grosjean, March, 316
epidemiology and statistics
—statistical data; new cases of tuberculosis discovered by case-finding surveys (ab), Mary Dempsey, Feb., 198
in infants and children
—obstructive emphysema and atelectasis in tuberculosis of infants and children (ab), Julio Meneghello and Clement A. Smith, June, 604
TUBERCULOSIS, PULMONARY
—bacteriological examinations supplementing routine thoracic radiography in Australian military forces (ab), Reginald Webster, Feb., 199
—importance of wheeze in diagnosis (ab), John S. Packard, Feb., 200
complications and sequels
—bronchiectasis secondary to pulmonary tuberculosis (ab), Arnold B. Rilance and Bruno Gerstl, Feb., 200
mass roentgenologic surveys
—adequacy of photofluorographic method of chest survey (ab), M. W. Mason, April, 406
—bacteriological examinations supplementing routine thoracic radiography in Australian military forces (ab), Reginald Webster, Feb., 199
—considerations on one thousand chest x-ray examinations performed on men applying for employment (ab), A. A. Bauer, Jan., 90
—critical and casuistic contribution on the theme "fluoroscopy in the Army" (ab), H. H. Weber, Jan., 90
—results of systematic fluoroscopy of an Army Unit on relief from service (ab), C. Frei, Jan., 90
—roentgenographic surveys for tuberculosis in Massachusetts and their importance to physician (ab), Philip E. Sartwell, Feb., 199
—statistical data; new cases of tuberculosis discovered by case-finding surveys (ab), Mary Dempsey, Feb., 198
—value of miniature chest films (ab), Arthur S. Webb, Jan., 90
—x-raying of school personnel (ab), R. R. Newell, Feb., 199
—x-raying of school personnel (ab), D. T. Proctor, Feb., 199
miliary
—miliary calcification (ab), Erving F. Geever, Jan., 90
TULAREMIA
—constrictive pericarditis due to Bacterium tularense. Report of case and review of reported cases of pericarditis occurring with tularemia (ab), B. V. Jager and J. C. Ransmeier, March, 303
TUMORS
adamantinoma
—report of 8 cases (ab), L. K. Chont, May, 511
adenoma
—of kidney with associated lesions; 3 cases (ab), Henry Bugbee, May, 521
angioma
—cavernous hemangioma of lung; secondary polycythemia (ab), Alfred Goldman, June, 606
—good result in radium treatment of extensive cavernous hemangioma (ab), W. Lutz, March, 315
—hemangioma of elbow successfully treated with radium at early age (ab), Ira I. Kaplan, April, 423
—hemangioma of synovial membrane of knee cured by synovectomy (ab), Paul H. Harmon, May, 516
—hemangioma of vertebra with compression of cord; report of case cured with radiation fourteen years ago (ab), L. Minor Blackford, May, 524
—"malignant" hemangioma (ab), Louis T. Byars, March, 315
—radiation treatment of lymphangioma (ab), George W. Holmes and Lloyd E. Hawes, Jan., 103
Ewing's
—of right femur, in epiphysis, with unusual pathological fracture (ab), Guillermo Halley, Jan., 103
—roentgenologic aspect of Ewing's tumor of bone marrow (ab), Paul C. Swenson, April, 417
—similarity of clinical and roentgen findings in children with Ewing's sarcoma (endothelial myeloma) with sympathetic neuroblastoma (ab), Robert P. Barden, June, 612
fibroma
—effect of roentgen rays on cell-virus associations; findings with virus-induced rabbit papillomas and fibromas (ab), Wm. F. Friedewald and Rubert S. Anderson, May, 529
—of stomach; case (ab), H. M. Wiley, Jan., 96
giant-cell
—of the lower femur. Case report with roentgen and pathological findings before and after curettage and roentgen therapy with amputation for sarcoma, F. B. Mandeville and John S. Howe, Jan., 56

TUMORS—*cont.*
myeloma
—*endothelial.* See Tumors, Ewing's
neuroblastoma
—*neuroblastoma sympathicum.* See Tumors, sympathoblastoma
osteochondroma
—of coronoid process of mandible (ab), Richard T. Shackelford and Webster H. Brown, Feb., 197
osteoma
—of frontal sinus; case (ab), W. H. Johnston, May, 511
—osteoid-osteoma (ed), May, 502
papilloma
—effect of roentgen rays on cell-virus associations; findings with virus-induced rabbit papillomas and fibromas (ab), William F. Friedewald and Rubert S. Anderson, May, 529
polypi
—multiple gastric polyposis; supplementary report of 41 cases, including 3 new personal cases (ab), Felix L. Pearl and Harold Brunn, Jan., 96
seminoma
—of testis, from standpoint of roentgen treatment (ab), Leo A. Nash and Eugene T. Leddy, March, 316
sympathoblastoma
—similarity of clinical and roentgen findings in children with Ewing's sarcoma (endothelial myeloma) and sympathetic neuroblastoma (ab), Robert P. Barden, June, 612
Wilms'. See Kidneys, tumors
TURNER, JOHN W.: Gastric herniation at the esophageal hiatus (ab), Feb., 202
TYSON, M. DAWSON: Surgical management of solitary cysts, or cyst-like structures, of pulmonary origin (ab), March, 302

U

UHLMANN, ERICH M., and GOLDNER, MARTIN: Use of the basal metabolic rate in the management of radiotherapy for leukemia, Feb., 165
ULCER
peptic. See Peptic Ulcer
UNDULANT FEVER
—Brucella spondylitis; case (ab), Martin Dobelle, May, 516
URETERS
abnormalities
—ureteral ectopia: report of rare case of ectopic ureter opening in uterus and review of literature (ab), Benjamin S. Abeshouse, March, 312
cancer
—primary carcinoma (ab), Samuel A. Jaffe and Anthony J. Mendillo, May, 520
obstruction
—management of hydronephrosis due to ureteropelvic obstruction; preliminary report (ab), Roy B. Henline and Joseph H. Menning, May, 519
—ureteropelvic obstruction due to extrinsic and intrinsic lesions of ureter as clinical entity and its treatment (ab), Clyde L. Deming, June, 613
URETHRA
stricture
—urethrograms in strictures; valuable aid in determining type of treatment (ab), George C. Prather, March, 313
URINARY TRACT
See also Genito-Urinary Tract; Kidneys; Ureters; etc.
—urinary tract changes with benign pelvic tumors, George W. Chamberlin and Franklin L. Payne, Feb., 117
calculi
—two unusual cases, Stuart P. Barden, March, 285
URINE
—estimation of renal function based on specific gravity changes following intravenous urography (ab), George O. Baumrucker, May, 518
UTERUS
—ureteral ectopia: report of rare case of ectopic ureter opening in uterus and review of literature (ab), Benjamin S. Abeshouse, March, 312
cancer
—carcinoma of cervix: study of 233 cases including 103 five-year cases with a survival rate of 33.9 per cent (ab), James R. Johnston, Feb., 212
—inadequate and ill-advised surgery in treatment of carcinoma of cervix (ab), L. C. Scheffey and G. A. Hahn, Feb., 212
—superficial noninvasive intraepithelial tumors of cervix (ab), Richard van D. Knight, May, 523
—treatment of carcinoma of cervix at Charity Hospital; preliminary report of end results (ab), Manuel Garcia and Leon J. Menville, April, 423
cervix. See Uterus, cancer
fibromyoma
—x-ray therapy of benign bleeding and fibromyoma (ab), Saul J. Tamarkin, June, 616
hemorrhage
—low-dosage irradiation to pituitary gland and ovaries in amenorrhea and dysfunctional uterine bleeding: long-time survey (ab), Leon Reidenberg, Jan., 103
—x-ray therapy of benign bleeding and fibromyoma (ab), Saul J. Tamarkin, June, 616
roentgenography
—aid in diagnosis of gynecological pelvic disorders (ab), Ben H. Brunkow, May, 517
—study of uterine canal by direct observation and uterogram (ab), W. B. Norment, May, 517
tumors. See also Uterus, cancer
—roentgenologic demonstration of spinal metastases from leiomyosarcoma of uterus (ab), Laurence L. Robbins, June, 613

V

VANCE, ROBERT G., and WYATT, GEORGE M.: Roentgenological manifestations of bone repair. Healing of fractures without external callus (ab), March, 310
Van DEMARK, ROBERT E. See **MEYERDING, HENRY W.**
Van LIERE, EDWARD J., and NORTHUP, DAVID W.: Emptying time of normal human stomach in the young adult (ab), April, 412
VEAL, JAMES R., and HUSSEY, HUGH H.: Thrombosis of the subclavian and axillary veins: report of 46 cases (ab), March, 314
VEINS
—spread of carcinoma of rectum; invasion of lymphatics, veins and nerves (ab), Philip H. Seefeld and J. Arnold Bargen, March, 307
axillary
—apparent causal mechanism of primary thrombosis of axillary and subclavian veins (ab), John J. Sampson, March, 314
—thrombosis of subclavian and axillary veins; report of 46 cases (ab), James R. Veal and Hugh H. Hussey, March, 314
roentgenography
—significance of phlebography in phlebothrombosis (ab), M. E. DeBakey, G. F. Schroeder, and A. Ochsner, June, 614
—use of venograms for localization and study of arteriovenous fistula (ab), James R. Watson, J. M. Lichty, J. M. Hill, and R. B. Miller, Jan., 102
—venography: I. Its use in differential diagnosis of peripheral venous circulation; II. Simplified technic (ab), Jerome Mark, May, 521
—venography of lower extremity: new technic—preliminary report (ab), Emile Zax, March, 314
subclavian
—apparent causal mechanism of primary thrombosis of axillary and subclavian veins (ab), John J. Sampson, March, 314
—thrombosis of subclavian and axillary veins; report of 46 cases (ab), James R. Veal and Hugh H. Hussey, March, 314
VERBERKMOES, J. G. See **FREDERICK, P. M.**
VERTEBRAE. See Atlas and Axis; Spine
VINSON, PORTER P.: Treatment of dysphagia from hernia though esophageal hiatus in diaphragm (ab), April, 412
VIRUSES
—effect of roentgen rays on cell-virus associations: findings with virus-induced rabbit papillomas and fibromas (ab), Wm. F. Friedewald and Rubert S. Anderson, May, 529
VOCAL CORDS
—atrial septal defect; report of two cases in which there was recurrent laryngeal nerve paralysis (ab), Herman Erlanger and Samuel A. Levine, May, 513
VOICE
—mechanism of phonation demonstrated by planigraphy of larynx (ab), Bruno L. Griesman, April, 406
VULVA
—roentgen therapy in ano-vulvar pruritus (ab), José L. Molinari and Anibal Lemos Ibáñez, May, 526

W

WALSH, MAURICE N. See **LOVE, J. GRAFTON**
WALTON, HENRY J., and DAVIDSON, CHARLES N.: Cholecystography: correlation of the roentgenological, surgical, and medical findings in 355 cases (ab), Feb., 204
WAR. See Military Medicine and Surgery
WARREN, LYMAN O. See **GASTON, EUGENE A.**
WATSON, JAMES R., LICHTY, J. M., HILL, J. M., and MILLER, R. B.: Use of venograms for the localization and study of arteriovenous fistula (ab), Jan., 102
WAUGH, JOHN M. See **BENSON, RAYMOND E.**
WEBB, ARTHUR S.: Value of miniature chest films (ab), Jan., 90
WEBER, H. H.: Critical and casuistic contribution on the theme "fluoroscopy in the Army" (ab), Jan., 90
WEBER, JOHN J. See **WEHRBEIN, HEINRICH L.**
WEBSTER, REGINALD: Pulmonary tuberculosis: bacteriological examinations supplementing routine thoracic radiography in the Australian military forces (ab), Feb., 199
WEEKS, KENNETH D. See **BAYLIN, GEORGE J.**
WEENS, H. STEPHEN. See **LESSER, LEONARD I.**
WEHRBEIN, HEINRICH L., and WEBER, JOHN J.: Multiple primary malignant lesions; 2 case reports (ab), April, 423
WEINBERG, ARTHUR, and SCADRON, SAMUEL J.: Value of pelvioradiography in the management of dystocia (ab), March, 311
WEISEL, WILSON, DOCKERTY, MALCOLM B., and PRIESTLEY, JAMES T.: Wilms' tumor of kidney: clinicopathologic study of 44 proved cases (ab), June, 615
WHEEZE
—importance of wheeze in diagnosis of pulmonary tuberculosis (ab), John S. Packard, Feb., 200

WHITCOMB, C. A.: Diagnosis of cervical metastasis from squamous carcinoma of the mouth and throat (ab), March, 300
Sarcoma of the tonsil. Impressions made by seven cases (ab), April, 406
WHITE, GEORGE. See **PENDERGRASS, EUGENE P.**
WHITE, MALVIN F. See **COAKLEY, WALTER A.**
WILEY, H. M.: Fibroma of the stomach: a case report (ab), Jan., 96
WILHELM, SEYMOUR F.: Laminography in the visualization of the suprarenal glands (ab), March, 309
WILLIAMS, CHARLES R., and EVANS, ROBLEY D.: Storage of radium dial instruments (ab), March, 318
WILMS' TUMOR. See Kidneys, tumors
WISSING, EGON G., and LOWMAN, ROBERT M.: Lateral view in the roentgenologic diagnosis of lesions of the colon (ab), Feb., 203
WITWER, ELDWIN ROY (ed), Jan., 81
WOLCOTT, W. EUGENE: Evolution of the circulation in the developing femoral head and neck: an anatomic study (ab), Feb., 204
WOLF, BERNARD S.: Nomographic aids in calculating radium dosage for plane and point sources, April, 368
WOLFF, ERNEST, and NOLAN, LEWIS E.: Multiple myeloma first discovered in the mandible, Jan., 76
——See **TOMLINSON, WRAY J.**
WOLIN, IRVING: Tabetic arthropathy of the hip, Jan., 79
WOOLFORD, ROBERT M., and OGURA, JOSEPH H.: Atypical (virus type) pneumonia with cor pulmonale (ab), March, 302
WOUNDS. See Trauma; and under organs and regions
WRIGHT, MYRON. See **PERRONE, HECTOR**
WU, Y. K. See **MENG, C. M.**
WYATT, GEORGE M. See **VANCE, ROBERT G.**

X

XANTHOMATOSIS
—xanthomatosis—Hand-Schüller-Christian type: report of a case with pulmonary fibrosis (ab), James H. Currens and Walter C. Popp, Jan., 92
X-RAYS. See Roentgen Rays

Y

YARNIS, HARRY, and COLP, RALPH: Lymphosarcoma of stomach (ab), June, 615

Z

ZAX, EMILE: Venography of lower extremity: a new technic—preliminary report (ab), March, 314
ZETENA, DOMINICK F. See **ROTHMAN, MILTON**
ZIADY, F., and SELZER, G.: Multiple cystic tuberculosis of bone (ab), Jan., 99
ZINC
—elimination of administered zinc in pancreatic juice, duodenal juice, and bile of dog as measured by its active isotope (Zn^{65}) (ab), M. Laurence Montgomery, G. E. Sheline, and I. L. Chaikoff, May, 529
ZISERMAN, A. J. See **AGERTY, H. A.**
ZYGOMA
fractures
—report of 72 consecutive cases (ab), Walter A. Coakley and Malvin F. White, May, 510